MAR 8 1937

Engineering News-Record

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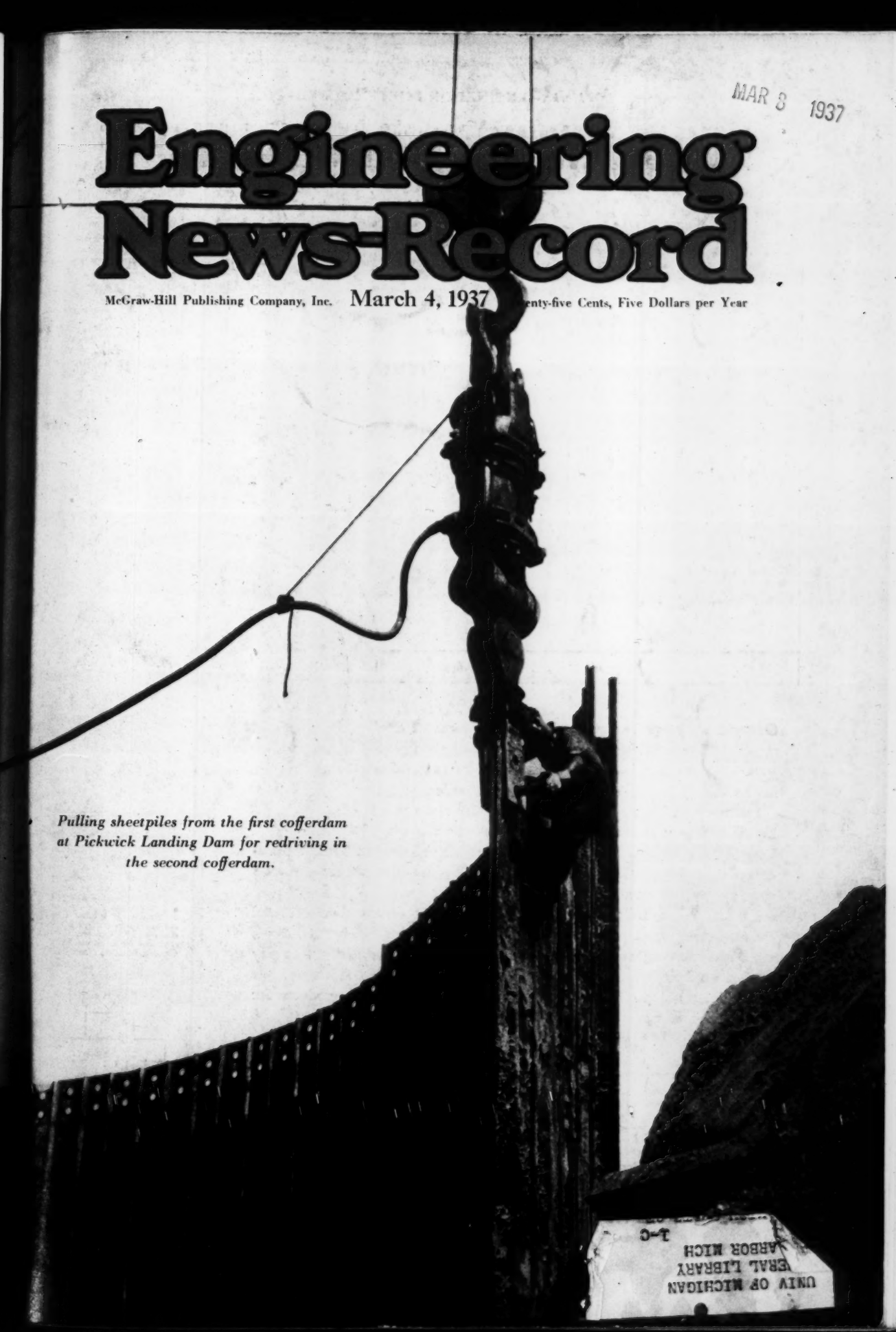

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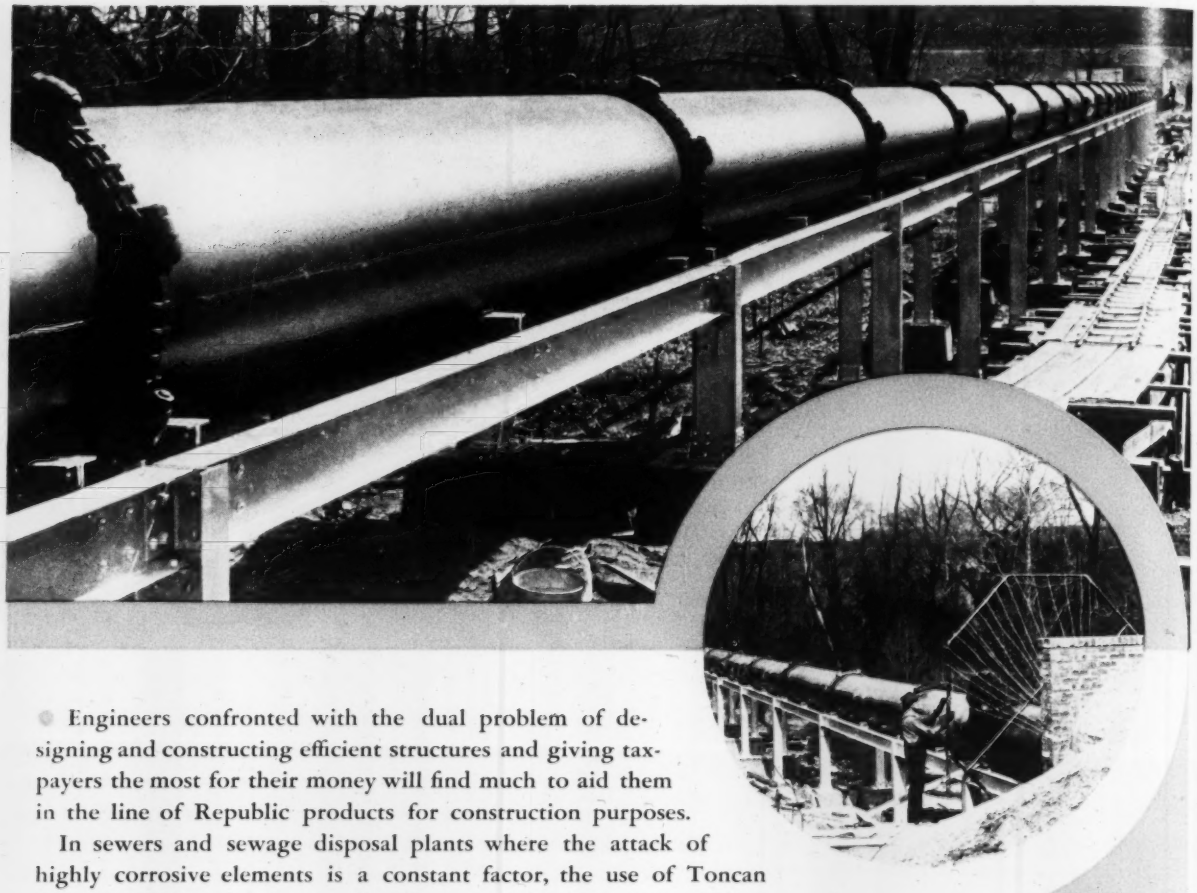

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"What For?" Rather than *"How Much?"*

FROM time immemorial men have associated death and taxes. To be sure, they have done it to connote inevitability; but as a result, much of the repugnance of death has attached itself to taxes. Misuse of the taxing power, popular outcry against taxes in the abstract, both have helped to build up a conception of taxes as an unpleasant and oppressive visitation.

So unreasoning an attitude does not help toward higher standards of public administration. It concerns itself only with the questions of high taxes or low taxes, my taxes or someone else's taxes, rather than with those of fair taxes or unfair taxes, good taxes or bad taxes, which mean, in effect, productive taxes or wasteful taxes.

In a recent press release the Twentieth Century Fund, which has been studying taxation, reminds us that, after all, the net *burden* imposed by taxes depends on the use that is made of them. It sets forth that the limit of the people's capacity to pay taxes is not a fixed sum or even a fixed proportion of their income. It all depends on how productively government spends the taxes.

"Unproductive expenditure," it says, "occurs when the government requisitions goods for destruction or pays to have production factors held idle." It occurs also when tax revenues are used "to support certain groups of people who themselves contribute nothing." And despite certain reservations and qualifications, it reaches the conclusion that "the support of large numbers of idle persons is the kind of expenditure that brings the taxable capacity limit near to the existing level of taxation."

THE net of all this is that when tax revenues are expended on useful services that minister to the productivity of the people, they are not a burden; when they do not do this they are, to just that degree, such a burden.

It must be recognized that in the administration of public funds we should expect no higher measure of perfection than prevails in private business. There must be a measure of waste in both. From time to time this page has pointed out that waste in operating management is likely to be less in private business because of the profit system. But waste will be there just the same, and if it be less in the field of management, it is likely to be far greater in that of finance, where, probably, private enterprise generates most of its burdensome waste.

The rational attitude toward taxation, therefore, is neither a blind reliance on an infinite taxing power, nor blind attacks on all public spending. No public function deserves more discriminating study and receives less. As with its running mate, death, everyone just naturally is against taxes.

But if we hope to conserve our progress in public administration, if we would continue to put at the service of our communities what science and technology have devised to enrich the productivity of community life, we must win more popular interest in the matter of *how* taxes are collected and *for what* they are spent. Constructive reduction can result only from such understanding.

Recently the St. Louis Department of Streets and Sewers issued its annual report for 1935-36. In contrast with so many such reports, it is alive, interesting and informative. Most stimulating of all, it carries as a title, "What the Taxpayer Gets for His Money."

THERE is the note on which we must hammer if we are to make progress toward sound taxation. We shall not make it by blind attacks on taxation, met by equally blind raids on tax revenues. We shall not get it by so vicious a misuse of the taxing power as, for example, the gas tax diversion. We shall not get it by condemning all public servants as less efficient than those in private business or by condoning lower standards of efficiency in public service than apply to private employment.

We shall make headway only when we put more effort into showing "what the taxpayer gets for his money." Then we shall begin to develop that discrimination which alone will make it possible to do something intelligent about it.

Willard Chevalier

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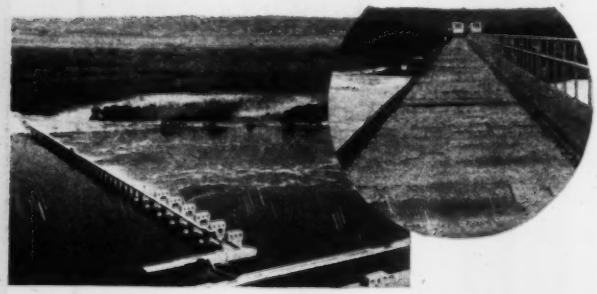
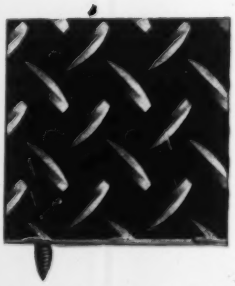


Here's another of the many uses for Inland 4-Way Floor and Traffic Plate. On Dam No. 5 of the Upper Mississippi River, at Winona, Minn., it provides safe footing and a solid, long-lasting steel floor. For walkways, heavy-duty industrial floors, bridge treads and crossings, the exclusive 4-way pattern of Inland traffic plate provides extra stiffness and extra protection against slipping feet or skidding wheels. Write for our illustrated booklet which contains complete information.



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March 4, 1937

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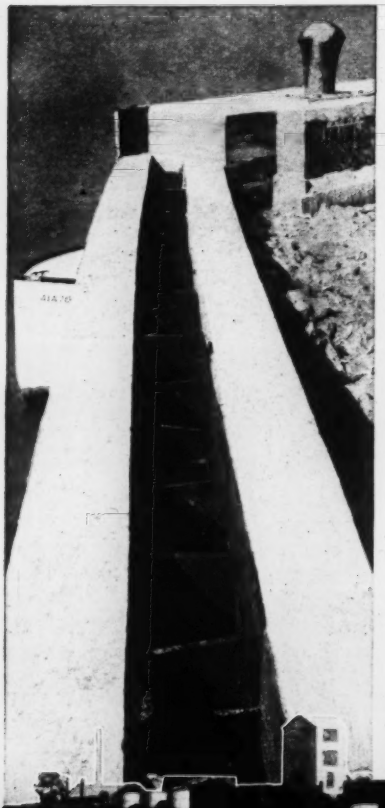
Safe School Construction—School Buildings suffered heavily in the 1933 earthquake in Southern California. The outcome was a school rehabilitation and construction program totaling $84,000,000, in which making the buildings safe against earthquake was the dominant factor. The important structural elements of that program are to be described in three articles beginning March 11.

Building for the Future



WITH MZ-32

HERE on the Maumee River, Toledo, Ohio, engineers and contractors were faced with the problem of building a dock wall that will meet both today's and tomorrow's needs. Designed to be used as an unloading dock for tankers of the Gulf Refining Company, this wall had to be constructed to carry heavy surcharge loads—had to be built to provide for deeper drafts of water for future lake shipments.

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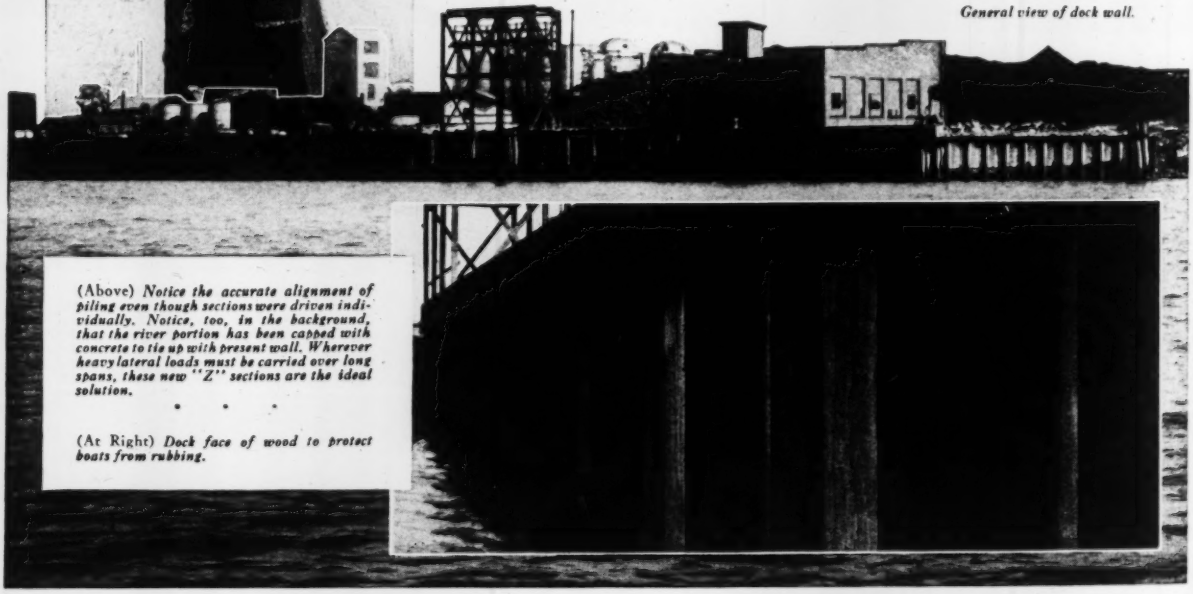
General view of dock wall.



(Above) *Notice the accurate alignment of piling even though sections were driven individually. Notice, too, in the background, that the river portion has been capped with concrete to tie up with present wall. Wherever heavy lateral loads must be carried over long spans, these new "Z" sections are the ideal solution.*

• • •

(At Right) *Dock face of wood to protect boats from rubbing.*

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ENGINEERING NEWS-RECORD

March 4, 1937

FIG. 1—OBSERVATION STATION below Boulder Dam for checking the retrogression of the river bed as the Colorado picks up a new load of silt.

Why Desilting Works For the All-American Canal?

By C. P. Vetter

Division Engineer, U. S. Bureau of Reclamation, Denver, Colo.

MANY ENGINEERS *and students of the behavior of the Colorado River have seriously questioned the necessity of the desilting works at the headgates of the All-American Canal. Will not the Boulder reservoir with its enormous silt storage capacity solve forever the silt problem on the lower river? The "turquoise waters" of the lake forming above Boulder Dam and the "crystal clear" stream emerging below it have been given wide publicity. From where, then, comes the 70,000 tons of silt per day which the desilting works at Imperial Dam are designed to remove? Mr. Vetter gives the answer to these entirely justified questions.* —EDITOR.

ON THE LOWER Colorado River 20 mi. above Yuma, Ariz., the Bureau of Reclamation has under construction a mechanical desilting plant of unprecedented magnitude. (See *ENR*, Oct. 17, 1935, p. 538). These works constitute a major feature of the diversion structure for the All-American Canal and are located immediately downstream from the Imperial Dam. The initial installation is designed to remove 70,000 tons of silt per day from the 12,000 sec.-ft. of water diverted, but provision is made for additional units should they later be required as the diversion is increased to the maximum capacity of the canal, which is 15,000 sec.-ft. The estimated cost of this installation, aside from diversion dam, headgates and canal, is over $1,500,000.

An outline is given herein of the studies and investigations that led to the final conclusion, that the only physically and economically feasible method of relieving the Imperial Irrigation District and its water users of the ever increasing burden of silt removal, would be to construct efficient desilting works at the headgates of the All-American Canal.

The earliest recorded silt observations on the lower Colorado were made at Yuma by C. B. Collingwood in 1892, and by R. H. Forbes in 1900 and 1904. During 1903 and 1905 observations were made at the same point by the U. S. Geological Survey. The Bureau of Reclamation has made regular silt observations twice a week at Yuma since 1911 and the Geological Survey has made observations at Topock, Ariz., since 1925 and at Yuma since 1926. All these observations give the per cent, by weight, of the suspended load. No attempts were made to analyze the silt for size or to determine the amount of bed-load. Typical relationships between discharge and suspended silt at Yuma, based on observations made by the Bureau of Reclamation, for the years 1920 and 1923 are shown in Fig. 2. It will be noticed

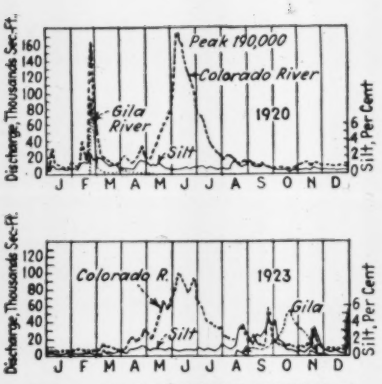


FIG. 2—SILT CONTENT CURVES of Colorado River compared with discharge during years of typical high, low and intermediate flows.

that the maximum silt content in per cent, as a rule, does not coincide with the maximum discharge. The spring and early summer runoffs, due to melting snow at high altitudes, are relatively low in silt content while floods in August and September caused by local storms carry great quantities of silt.

In order further to investigate the laws governing the silt transportation in the river, a more thorough program of silt investigations was initiated by the Bureau of Reclamation in 1933. The purpose of the investigations was twofold: To establish, if possible, the extent of the bed-load and its relation to the suspended load, and also to determine particle sizes of the total load and of the material constituting the bed of the river. The silt observations were made at Laguna Dam, 15 mi. above Yuma, and at the Imperial dam site, 4.5 mi. above. At Laguna Dam observations were made at points along the overflow crest, in the Yuma canal immediately below the point of diversion and in the sluiceway at the canal headgates. It was thus possible to obtain a record of the total load of the river, that is, suspended load plus bedload. Samples were secured by means of a Binckley sampler similar to that shown in Fig. 3. The silt samples were analyzed by sieves and hydrometers and the quantity, expressed in tons per day as a function of discharge, was plotted in seven size groups according to the diameter of the grains as follows: Grade 1, larger than 0.25 mm.; grade 2, 0.10-0.25 mm.; grade 3, 0.05-0.10 mm.; grade 4, 0.03-0.05 mm.; grade 5, 0.01-0.03 mm.; grade 6, 0.005-0.010 mm.; and grade 7, smaller than 0.005 mm. The quantity of grade 1 (larger than 0.25 mm.) appeared to be very small, consisting mainly of floating debris. In the coarser grades there is a fairly well-defined relationship between the total load and the discharge. As the material gets finer the points scatter more and more, and no relationship appears to exist between the discharge and material finer than 0.01 mm.

At Imperial Dam site measurements were taken of the suspended load only. The results are shown on Fig. 4 as are the visual averages of the observed points as compared to the visual averages for the total load at Laguna Dam.

Finally a series of borings was made, between the Imperial dam site and the Parker dam site, 150 mi. upstream, to determine the character of the material in the river bed to a depth of 30 ft. A typical sieve analysis curve from one of these sets of borings is shown on Fig. 5. Holes 2, 3, and 4 were located in the river bed proper while holes 1 and 5 were located in the banks. The average size of the material in the river bed is somewhat coarser than that in the banks and was found to range from about 0.05 mm. to 0.6 mm. (270-28 mesh). This range of sizes is precisely the one for which the silt observations at Laguna and Imperial Dams indicated a relationship between quantity and discharge.

Insignificant bed-load

A study of the charts showing the plotting of the samples disclosed no consistent difference between the total load at Laguna Dam and the suspended load at Imperial Dam site. The conclusion is drawn that the suspended load constitutes by far the major portion of the load carried by the river.

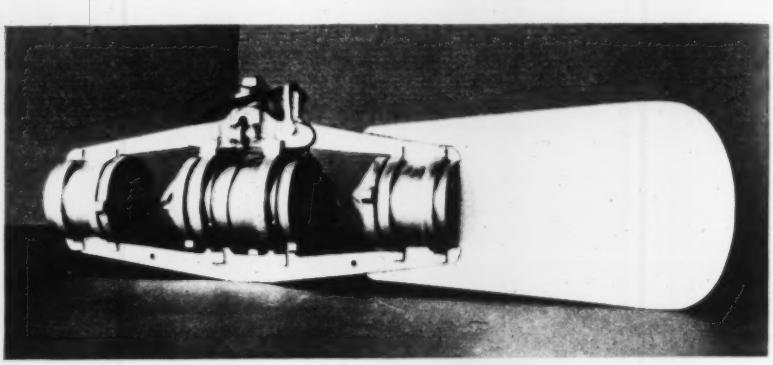
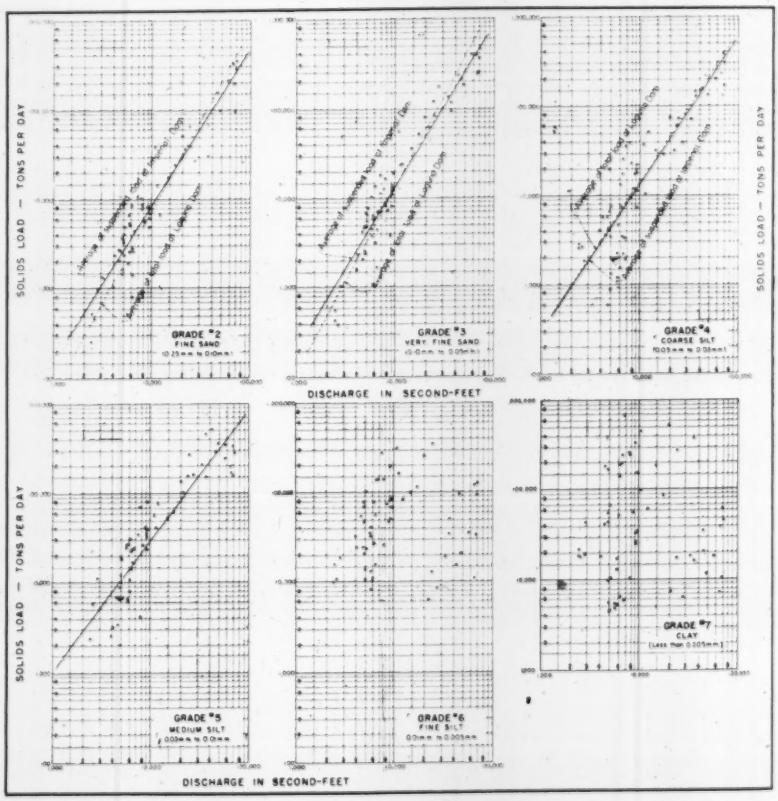


Fig. 3—SILT SAMPLER in closed position.

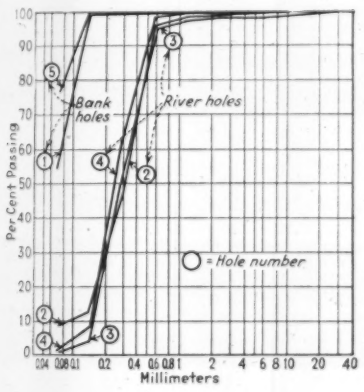
FIG. 4—SUSPENDED LOAD at Imperial Dam site compared with total load at Laguna Dam.



There are obviously local movements of sand bars which must take place as bed-load movements, especially when the stage of the river is changing, but over a longer stretch, taken as a whole, the investigations indicate that the bed-load movement is insignificant.

This conclusion also seems justified by the following reasons: In a flowing stream the movement of individual water particles may be divided into two classifications, currents and turbulence. By currents is understood movements by which the whole mass of water or a considerable portion of it has an approximately uniform velocity. The movement of a stream as a whole would then be classified as a current and the direction of the current would be approximately parallel to the stream bed. By turbulence is understood the constantly changing, random velocities which are superimposed on the practically uniform velocities of the currents. The turbulent velocities, at a given time, change from point to point in the fluid, and, at a given point, change rapidly with time. The turbulent velocities originate at the contact surfaces between the stream and the bed, in that the vortex sheet, constituting the boundary layer of the stream, transmits rotating velocities to the main body of water.

Fig. 5—**TYPICAL ANALYSES** of material from a boring 10 ft. deep at Mile 592 on bank and in river bed.



As a result of turbulence the water particles, and with them the suspended particles of solid matter, are being constantly mixed. In the course of this mixing process a certain number of silt particles will strike the bottom of the stream and, at the same time, a certain number of particles will be torn loose from the bed by the boundary layer and thrown into the stream. If the number of particles which, per unit of time and area, are thrown into suspension equals the number which, in the same time interval and on the same area, hit the bottom, the stream may be said to be in equilibrium and the silt content will be constant. In other words if the silt-laden stream is in equilibrium, the intensity of the boundary layer will be able to maintain a certain silt concentration in the layers adjacent to the bed. If this concentration is given, it is possible to calculate the concentration at any other depth. This concentration is not constant with the depth; it decreases toward the surface of the stream due to the decreasing intensity of the turbulence and also due to the specific nature of random movements of this nature under the influence of gravity.

The mechanics of bed-load movement is entirely different from that described above. G. K. Gilbert offers the following definitions of the two modes of transportation:

"Streams of water carry forward debris in various ways. The simplest is that in which the particles are slid or rolled. Sliding rarely takes place except where the bed of the channel is smooth. Pure rolling, in which the particle is continuously in contact with the bed, is also of small relative importance. If the bed is uneven, the particle usually does not retain continuous contact but makes leaps, and the process is then called saltation. With swifter current leaps are extended and if a particle thus freed from the bed be caught by an ascending portion of a swirling current its excursion may be indefinitely prolonged. Thus borne, it is said to be suspended, and the process by which it is transported is called suspension. There is no sharp line between saltation and suspension, but the distinction is nevertheless important, for it serves to delimit two methods of hydraulic transportation which follow different laws. In suspension, the efficient factor is the upward component of motion in parts of a complex current. In other transportation, including saltation, rolling and sliding, the efficient factor is the motion parallel with the bed and close to it."

Since in the lower Colorado River the grain sizes of the bed material correspond closely to the grain sizes found in suspension it seems reasonable to expect that particles torn loose from the bed by the disturbance in the boundary layer will remain in suspension until a descending velocity makes them again strike the bottom. Under these conditions true bed-load, as defined by Gilbert, is not likely to exist.

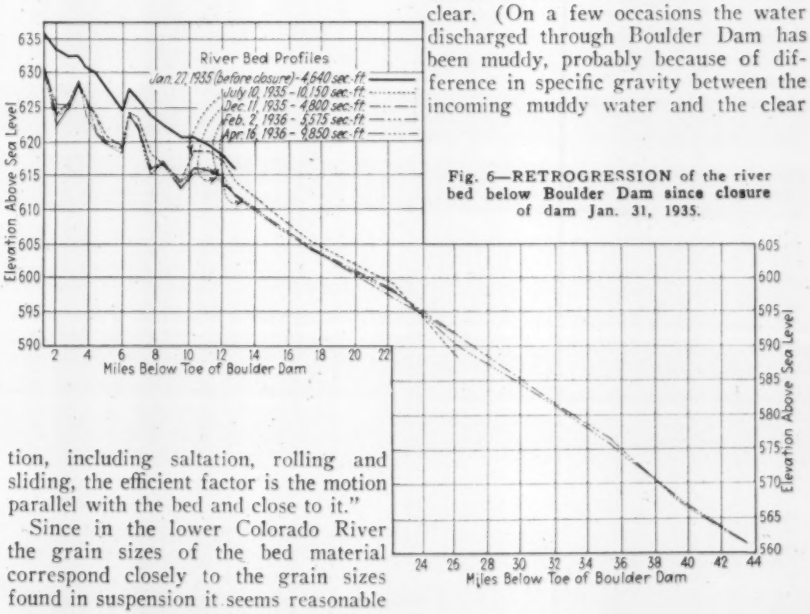
This reasoning would also explain the observed fixed relationship between the discharge and that part of the suspended load that lies within the range of sizes available in the bed. As long as the discharge and the slope of the river are constant the intensity of the boundary layer, and the concentration of suspended matter maintained by it, is undoubtedly also constant. The fine material, not available in the bed of the stream for many miles upstream from the point of observation, must originate elsewhere on the river or on its tributaries and it cannot be expected that any fixed relationship should exist between the discharge and the load of the finer material. Bearing in mind that the term "saturation" should probably be used with caution in this connection, the phenomenon can, nevertheless, be illustrated by saying that the stream is saturated with the material freely available in the bed but under-saturated with material finer than that found in the bed.

Yet another conclusion may be drawn from the above reasoning. If the part of the silt load which lies within the range of sizes abundantly available in the bed bears a fixed relationship to the discharge there is no reason to believe that this relationship will be materially changed if the finer part of the load is partly or entirely eliminated.

Retrogression observations

After the closure of the free outlet gates at Boulder Dam the regulated outflow from the reservoir soon became clear. (On a few occasions the water discharged through Boulder Dam has been muddy, probably because of difference in specific gravity between the incoming muddy water and the clear

Fig. 6—**RETROGRESSION** of the river bed below Boulder Dam since closure of dam Jan. 31, 1935.

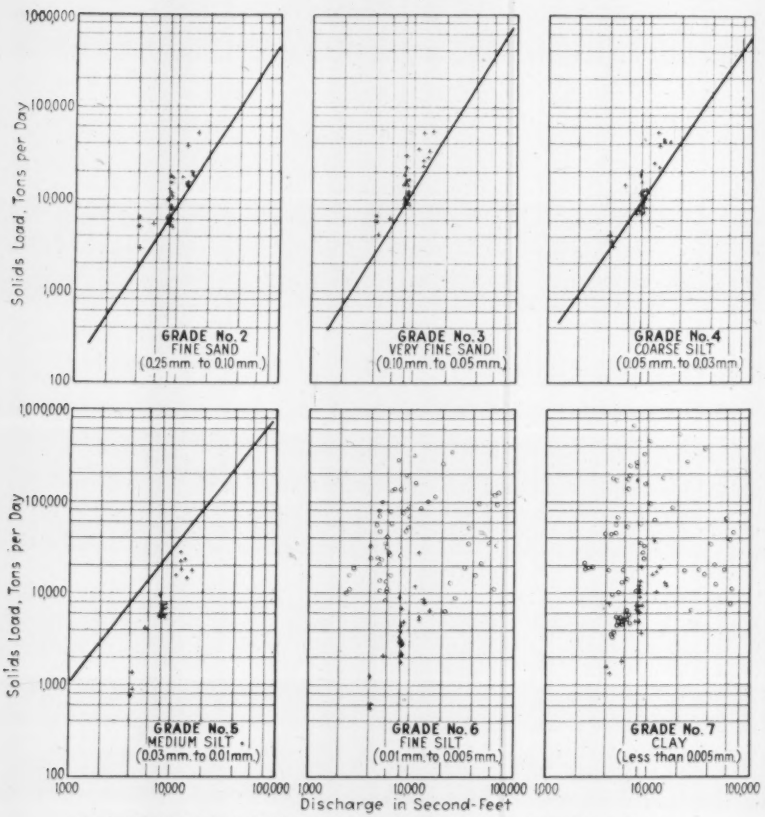

River Bed Profiles
Jan. 27, 1935 (before closure) - 4,640 sec.-ft.
July 10, 1935 - 10,150 sec.-ft.
Dec. 11, 1935 - 4,800 sec.-ft.
Feb. 2, 1936 - 5,575 sec.-ft.
Apr. 16, 1936 - 9,850 sec.-ft.
Elevation Above Sea Level
Miles Below Toe of Boulder Dam

water in the lake. A similar phenomenon has been observed at Elephant Butte Dam in New Mexico.)

Since the grade of the river below the dam was established by water loaded to capacity with silt, the clear water now discharged picks up material from the river bed, causing retrogression below the dam. In order to follow the retrogression in detail, 23 observation stations have been established below the dam. The result of retrogression observations to date is shown on Fig. 6. (See also similar diagram *ENR* Oct. 17, 1935, p. 540.) It will be noted that at several points the river bed appears to offer considerable resistance to erosion. Analyses of samples of the bed material indicate that the bed at these points consists of coarse gravel and small boulders while the bed in the intervening stretches consists of fine sand and silt. Whether these gravel banks will be able to check the erosion for any length of time depends mainly on their extent up and downstream. If they cover only a short stretch of the river the progressive undermining of their downstream edge, due to the erosion of the finer material, may eventually cause a material retrogression even of these more resistant stretches. As the river becomes loaded with silt picked up from the bed the stable slope becomes steeper until a point is reached where the river is saturated with material of the sizes available in the bed and where, consequently, the existing river grade is stable. Between the time of the closure of the free outlet gates at Boulder Dam on Feb. 1, 1935 and June 16, 1936, about 4,700,000 cu. yd. of material have been eroded from the river bed between Boulder Dam and Station 16, a stretch 13 mi. long. An additional 4,800,000 cu. yd. have been eroded between Stations 16 and 23, a stretch 31 mi. long.

In addition to the retrogression measurements below Boulder Dam, silt observations are being made at the Imperial dam site so as to establish the amount and character of the silt load as compared with conditions before storage of water in Boulder Dam Reservoir. From Fig. 7, showing the results to date, it may be seen that the points representing the coarser part of the load group themselves fairly well along the lines representing the average of the observations taken before closure of the free outlet gates at Boulder Dam. The finer part of the load has been considerably reduced because the material, having once been removed from the stream in Boulder reservoir, is not available in great quantities in the river bed below.

FIG. 7—AMOUNT AND CHARACTER of silt load at Imperial Dam site before and after closure of Boulder Dam. The finer part of the load was considerably reduced but the coarser part remained essentially the same after closure.



Note.—*The line shown in the above charts was determined from observations prior to closure of Boulder Dam*
• = *Observations prior to closure* + = *Observations after closure*

Silt entering Imperial reservoir

Certain predictions may now be made of the future silt load entering the Imperial reservoir. Imperial Dam and Parker Dam 150 mi. upstream will be completed at about the same time. The Parker reservoir with a storage capacity, to lowest water level, of 5[illegible],000 acre-ft. might conceivably hold all the silt that will be eroded from the river bed between Parker and Boulder dams, a distance of 150 mi. Except at the rare occurrence of a flood in the Bill Williams River, a tributary to the Colorado immediately upstream from Parker Dam, the outflow from Parker Reservoir will probably be clear for many years to come. Below Parker Dam the clear water will pick up material from the river bed until the stream has become saturated with silt of the sizes available in the bed. The quantity of coarse material carried for a given discharge should be about the same as it was before the two dams were placed in operation; the fine material will be materially reduced. Where the river enters the Imperial reservoir, using the chart shown in Fig. 4 and assuming a discharge of 18,000 sec.-ft. corresponding to the average run-off, the quantities would be as follows:

Size in mm.	Total Load in Tons per day
0.25–0.10	26,000
0.10–0.05	40,000
0.05–0.03	39,000
Total	105,000

Since the total load varies approximately with the second power of the discharge, intermittent greater flows will materially increase the load. At 40,000 sec.-ft. discharge the total load would, under these assumptions, be 400,000 tons per day distributed as follows:

Size in mm.	Total Load in Tons per day
0.25–0.10	100,000
0.10–0.05	170,000
0.05–0.03	130,000
Total	400,000

Silt entering All-American Canal

It may be confidently expected that as progressive erosion takes place below Parker Dam the longitudinal profile of the river will become convex, starting below the dam with a very flat slope which will gradually become steeper and eventually reach a point where it is tangent to the existing slope of the river. Simultaneously with the change in profile, the Imperial reservoir will be silting up. This process is very similar to the delta building at the mouth of a silt-laden river, and has been studied in detail by means of a 1:40 scale model at the Montrose (Colo.)

laboratory of the Bureau of Reclamation. Fig. 8 shows the delta building in the model.

During the period of silting of the Imperial reservoir the amount of coarse material passing the headgates of the All-American Canal will doubtless be small. However, the storage capacity of the reservoir to the sills of the headgates is only about 21,000 acre-ft. While, as noted above, the average inflow of material coarser than 0.03 mm. has been estimated at 105,000 tons per day, the total quantity entering the reservoir may be expected to be considerably in excess of this amount. Since 105,000 tons per day correspond to 21,000 acre-ft. per year, it is seen that within a relatively short period of time the accumulated silt in the reservoir may be expected to reach the sills of the headgates.

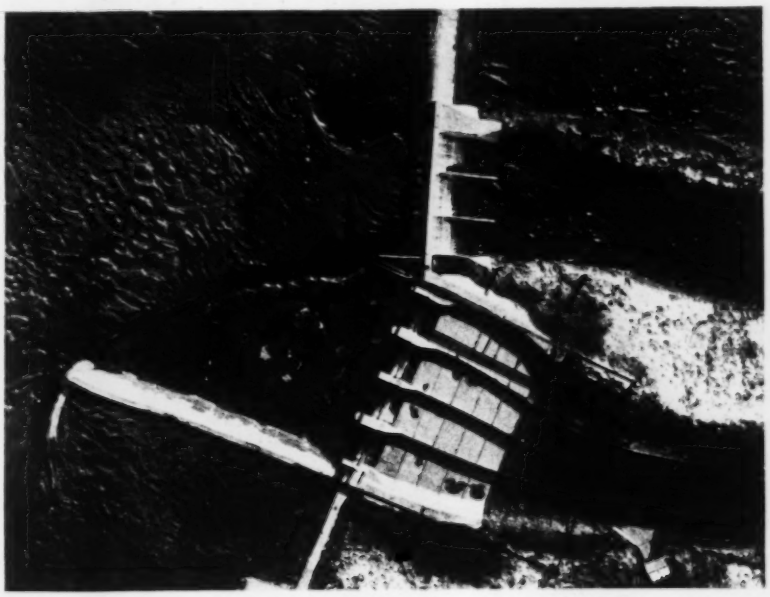
It is anticipated that the very fine, colloidal part of the silt load will begin to pass through the headgates long before the accumulated silt reaches the elevation of the sills, and this fact will be of considerable aid during the priming period of the canal. If desired, during the initial period of operation, the amount of silt entering the canal may be increased by keeping the reservoir at a low level and causing the flow to bypass the desilting basins.

Estimates have been made of the approximate amounts of coarse load that will pass through the All-American Canal headgates at various times after closure of the Imperial Dam. All such estimates were arrived at by balancing the volume eroded below Parker Dam against that deposited in the storage space above Imperial Dam and that entering the All-American Canal or passing the dam. The variation in silt-carrying capacity as the river slope changes was also taken into account in the estimates. This assumed relationship of load to slope was obtained from observations at fifteen measuring stations on eleven different rivers carrying a comparable silt-load.

At the present time the available knowledge of the laws of silt transportation does not permit consideration of the effect on the degradation rate of a possible change of particle size of the bed material. Disregarding this effect, it has been estimated that after five years of operation more than 30,000 cu. yd. (19 acre-ft.) of coarse silt per day will enter the All-American Canal headgates, when the rate of diversion amounts to 12,000 sec.-ft. As the silt accumulates above the dam and the slope of the delta becomes steeper, the amount of silt reaching the headgates will doubtless increase and it is estimated that the amount entering the headgates with a diversion of 15,000 sec.-ft. may eventually reach 60,000 cu. yd. per day (37 acre-ft.). This latter quantity, corresponding to 1,800,000 cu. yd. per month, may be visualized by comparison with the total excavation of the All-American Canal for the month of September 1936, which amounted to 1,250,000 cu. yd. Using the same assumptions and the same method of computation the total volume brought into the desilting works during the first ten years of operation has been estimated to be approximately 80,000,000 cu. yd. (50,000 acre-ft.). The computations further indicate that, during successive 10-yr. periods, the volumes may be more than doubled before, eventually, the depletion of available material causes a reduction of the amounts carried into the desilting works.

FIG. 8—DELTA BUILDING in 1:40 scale model of Imperial Reservoir at Montrose Laboratory in Colorado.

FIG. 9—MODEL OF HEADWORKS for the All-American Canal at the Montrose Laboratory. The lower structure is the intake with the sluiceway above.



In these estimates it has been assumed that no natural controls will be uncovered in the river bed between Parker and Imperial dams as the erosion progresses, and that no barriers will be constructed. Except in the canyon below the Parker dam site, and at a point 20 mi. below the town of Parker, no material that might form permanent controls was found by borings to a depth of 30 ft. in the river bed. It is not believed that any material other than boulders or ledge rock will form a control of any considerable height, unless coarse material in great longitudinal extent is encountered. Available information gives no indication of riffles composed of cobbles and boulders similar to those below the Boulder Dam, and it is not likely that such controls will be found below the Parker gorge. The borings show some increase in coarseness of the material with depth, but the composition of the alluvial banks is roughly comparable to that of the present river-bed surface. Coarse sand, and perhaps small stones, are doubtless brought into the river at the dry washes from the mesa country, but the gradients are not sufficient to bring in boulders or cobbles.

If desilting works were not constructed the silt passing the headgates would be carried into the canal. The

canal is designed for a velocity of 3.75 ft. per sec. when operated at full capacity of 15,000 sec.-ft. At this velocity the silt probably will be carried along and deposited in the laterals and ditches of the irrigation system. For many years, however, the velocity will rarely, if ever, reach 3.75 ft. per sec. It is estimated that for several years the minimum diversion may be as low as 6,700 sec.-ft., or about 45 per cent of the designed capacity. At other points farther down the canal the minimum flow will be an even smaller fraction of the designed capacity. Since it is necessary, or at least desirable from the point of view of maximum efficiency, to maintain the water level in the canal as high as possible above power drops where generating equipment is installed, the velocity of flow for considerable distances above such power plants will be only a fraction of the velocity required to keep all the silt moving. The main canal will thus act as a settling basin above each power plant.

Removal of the silt deposited in the canal by sluicing after consolidation requires very high velocities, hence this method is believed to be impractical. Bridges and wash crossings in certain reaches make it impossible to move a dredger along the canal for any great distance, thus precluding dredging as a method of removal. The only practicable method of silt removal for many miles of canal would be the use of draglines, operating either from embankments or berms. The cost of operation under these conditions would be high, and in many places disposal of the silt by this method would be almost impossible. According to the estimate the average yearly amount of coarse silt entering the All-American Canal during the first ten years of operation may be approximately 8,000,000 cu. yd. Out of this amount it is estimated that the desilting works will eliminate 5,000,000 cu. yd. per year, the removal of which by draglines or other means after being carried into the canal might cost as much as 20¢ per cu. yd., or $1,000,000 per year. The remaining 3,000,000 cu. yd., being mostly finer than 0.05 mm., will probably be carried on through the system. If this quantity proves to be objectionable it can largely be removed by the addition of such of the remaining units of the total desilting installation as may be necessary. As compared with the above $1,000,000 yearly expenditure, the total construction cost saved by omitting the proposed desilting works would be about $1,500,000. Furthermore, the construction of desilting works, should they be found necessary after the canal has been placed in service, would be extremely difficult due to the necessity of practically continuous operation of the canal.

It might be possible, by operating the main canal without checking, partially to prevent silt deposits in the canal itself; however, the silt load would then be carried on to laterals and ditches and to the irrigated fields, making silt removal even more difficult and costly. Such a method of operation would cause a material power loss.

Conclusions

It is recognized that any prediction now made, based on past studies and investigations, may vary widely from the actual facts revealed later when more observations on the future behavior of the Colorado River become available. Nevertheless, as expressed in an early report by the All-American Canal consulting board, "it is considered an inescapable fact that for many years in the future the volume of silt passing the headgates of the canal and demanding disposal of in one way or another will be a very large quantity, of the order of many millions of cubic yards per year, or of many thousands of acre-feet per year, also that such volume of silt if allowed to enter the system of the All-American Canal would be in large part deposited in the canals, laterals and ditches of the system and in part carried on to the land, and in either or both cases constitute a serious difficulty in the operation of the canal and occasion a very large annual charge for its removal."

The All-American Canal desilting plant is believed to be fully justified and its construction was decided on only after careful engineering studies had indicated, beyond any shadow of doubt, that only by the construction of silt disposal works of unprecedented magnitude could the All-American Canal be made a technical as well as an economical success.

The Imperial Dam and desilting works and the All-American Canal are part of the Boulder Canyon project, authorized by Congress in the Boulder Canyon Act, and are being built by the Bureau of Reclamation, Department of the Interior. John C. Page, commissioner, is administrative head of the Bureau of Reclamation. All engineering and construction work is directed from the Denver office under R. F. Walter, chief engineer, S. O. Harper, assistant chief engineer, J. L. Savage, chief designing engineer, and W. H. Nalder, assistant chief designing engineer. Designs of the Imperial Dam and desilting works have been prepared by the writer under the direction of H. R. McBirney, senior engineer, in charge of canal designs. E. W. Lane, now professor of hydraulics at University of Iowa, and S. Shulits, now assistant professor at Colorado School of Mines, have had charge of much of the silt investigation work.

The All-American Canal consulting board has reviewed the plans for the desilting works. The members of the board are: C. P. Berkey, W. F. Durand, L. C. Hill and Joseph Jacobs. D. C. Henny was a member of the board to the time of his death.

Attracting Better Candidates for Civil Service Tests

ATTRACTING competent candidates into government work should be as important a concern of civil service commissioners and personnel directors as picking the best man for the job by the actual civil service tests, according to the Civil Service Assembly of the United States and Canada. For this reason the Assembly has issued a pamphlet which describes the method devised by the California state personnel board to call in competent candidates for employment in state departments.

About three years ago it occurred to personnel technicians William Brownrigg and Louis J. Kroeger that advertising civil service jobs by placards in post offices, public libraries and other public places reached chiefly loungers and other unqualified persons. Little was done to attract and encourage better qualified candidates who probably already had jobs, to compete in civil service examinations. The remedy for the situation, they decided, was a positive program to interest citizens and advise them directly when civil service examinations were due.

The chief tool, they found, was a good mailing list which, through a punch-card system of selection, would automatically notify possible candidates well in advance of an examination for which they would qualify. Starting the system in 1934, just after a new civil service constitutional amendment went into effect, and when the public was acutely conscious of government employment, the board made up a qualification list of citizens who signified an interest in government work. The qualification cards, which contained information in terms of education, experience and interests, were scanned by trained personnel technicians, who coded them for notification in all possible fields of talents. Now, when an examination for a particular job is scheduled, the cards are sorted for potential candidates, who receive postcard notices. Within the month those who have received notices must write in for an application if they wish to take the test. The end result is a selected group from which the best qualified can be chosen by civil service test.

Pile Pulling and Re-Use Cuts Cofferdam Cost

Three equal cofferdams are being built of the same sheetpiles by pulling and re-using them twice at Pickwick Landing dam

LARGE ECONOMIES are being made in the construction of Pickwick Landing dam, now being built by the Tennessee Valley Authority across the Tennessee River 53 miles below Wilson Dam, by so planning the operation as to allow the use of the same steel sheetpiling for all of the three cofferdams. This involved pulling and reconditioning the piles before re-use, and required a cofferdam layout that could use about the same quantity of piling for the cofferdam in each of the three stages of construction. The cost of pulling and reconditioning the sheetpiles of the lock cofferdam for use in the second-stage cofferdam was only 15 per cent of the cost of new piling.

The cofferdam consisted of twenty-four 59-ft. cells and two connecting cells of 41-ft. diameter, driven through from 10 to 15 ft. of gravel overburden to the flat rock underlying the site. The main cells were placed 62 ft. center to center and were connected by two arched segments of 10 piles each. Upper and lower cut-off walls, totalling about 800 ft. long, were driven to rock to seal the land ends. All piling was of 15-in. flat-web interlocking steel sheeting weighing 38.8 lb. per ft.; it averaged 51.3 ft. long. The piling on the river side was about 55 ft. high, from rock, while that on the land side was 5 ft. lower. All cells and connecting arched web sections were filled to El. 585 by hydraulic dredging.

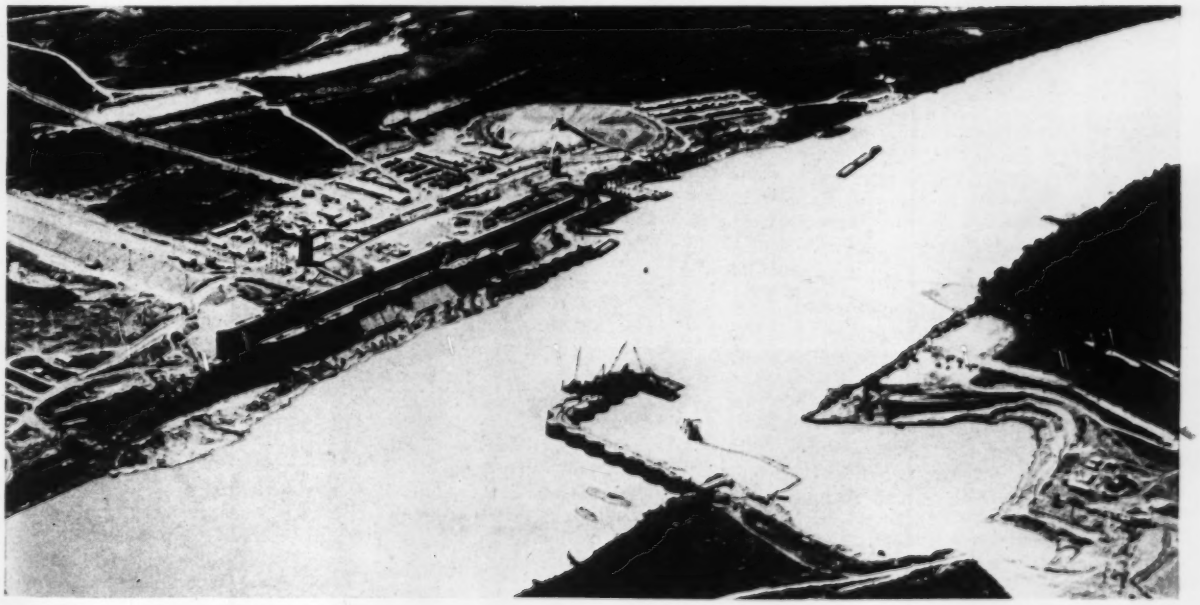
Prior to pulling

Pile pulling in the lock cofferdam was scheduled to proceed simultaneously with the driving of the second-stage cofferdam (on the opposite side of the river) to obviate storing and rehandling the piling; therefore careful planning of both operations was required for best economy. The resistance to pulling of the cutoff wall piles was largely due to the high tension developed in the interlocks of the filled cells.

Excavation of the material on both sides of the cutoff walls and of the fill in the cells resulted in greatly reducing the required pull, and was done for all piling except for part of the upper cutoff wall, where it was undesirable to disturb the earth fill already in place. Experience indicated, however, that excessive excavation of the material near the cutoff walls made pulling difficult because several adjacent piles tended to come up with the one being pulled. From 40 to 50 per cent of the fill was removed from the cells of the cofferdam, leaving the remaining material in a cone-shaped heap in the center. Initial excavation near the first pile to be pulled in each cell was carried down practically to water level to equalize the pressure on the two sides and relieve the high interlock stresses.

FIG. 2—SHEETPILES from the first cofferdam at Pickwick Landing Dam are being pulled for re-use twice in succeeding sections of cofferdam; an 800-lb. steam-powered ram pile-extractor handled by a traveling crane does the pulling.

FIG. 1—SHEETPILE COFFERDAMS of about equal wall length are being used for each of the three stages of construction at Pickwick Landing to permit re-use of the maximum amount of the piles in the first cofferdam. The lock on the south bank was built first and this photo, taken last August, shows the cofferdam for that structure being dismantled to build the cofferdam for the powerhouse section of the dam.



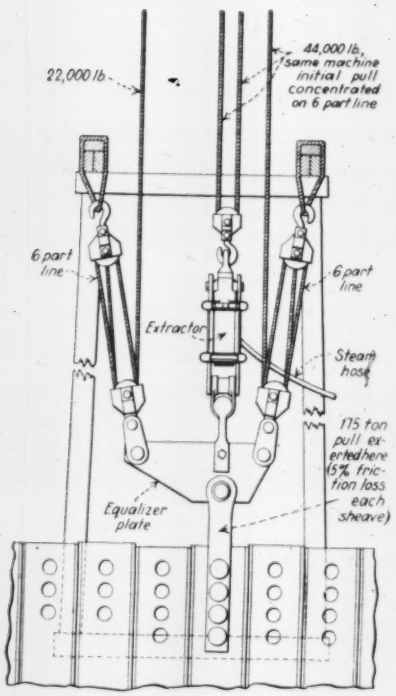

22,000 lb.
44,000 lb. (same machine initial pull concentrated on 6 part line)
6 part line
6 part line
Extractor
Steam hose
175 ton pull exerted here (5% friction loss each sheave)
Equalizer plate

FIG. 3—ON PILE PULLING at the Pickwick Landing Dam when great resistance was encountered two cranes were used to provide a direct pull of 175 tons; the drawing shows the device for equalizing the lifting forces of the two cranes.

which are greater for the first pile pulled than for any other pile.

An electric revolving crane with straight steel boom 95 ft. long was mounted on 16-ft.-gage railway track on the cofferdam and handled the steam-powered 800-lb. ram pile extractor during pulling and a clamshell bucket during excavating. After pulling each pile the crane stacked it on an adjacent cofferdam cell. An oil-fired steam crane with 90-ft. boom was mounted on a 62x34-ft. barge and was equipped with a clamshell bucket for excavating. It also loaded the piles from the stack on the cofferdam to the barges for transportation to the piledriving operations. The maximum safe crane pull of 22 tons was applied to the extractor, designed to withstand a line pull up to 25 tons. This equipment was satisfactory when the piles were loosened by excavation.

Special pulling outfit

On part of the upper cutoff wall, where no excavating was done, a special pile-pulling arrangement was developed to permit of applying up to 175 tons direct pull and the blows of the pile extractor at the same time. This arrangement used the revolving crane and a crane-rigged power shovel, each operating through a 6-part line, with the upper sheaves supported on a heavy timber A-frame. The method of equalizing the lifting forces of the two cranes and the attachment of the extractor in the rigging is shown in Fig. 3. This rig pulled 150 piles. It was necessary to increase the 2-in. holes in the piling to 4 in. to attach the lifting device securely to the pile. The disadvantages of the use of the sheave arrangement for applying the high lifting force was that the equipment was bulky to handle, which increased the pulling time materially.

Time studies indicate that the average time for connecting, extracting and stacking each pile was 6.3 min. Removal of the cells was done in four steps: (1) clamshell excavation in the main cell, (2) pulling main cell piles, (3) clamshell excavation in the arc and web section, and (4) pulling the piles in the web section—the four operations requiring an average time of 35 hr. per cell. This average would have been less had it not been desirable to pile the excavated material carefully to form a temporary earth dike along the lock area to allow completion of lock work in the dry.

Timber Ski Jump 180 Ft. High Built at Chicago Stadium

Towers and bracing trusses assembled from shop fabricates pieces with split-ring connectors—Footings are stone filled cribs above ground

By Ira D. S. Kelly

Structural Engineer, National Lumber Manufacturers Assn., Chicago, Ill.

THE TALLEST free standing ski jump structure in the United States was built at Soldiers Field, Chicago, during January and used on February 7 for the Central United States Ski Association annual competition, sponsored by the Chicago Daily Times and witnessed by some 65,000 spectators. Built of timber framing with split ring connector joints, the structure, which rises 180 ft. at its highest point, was designed to be demounted and stored during the summer.

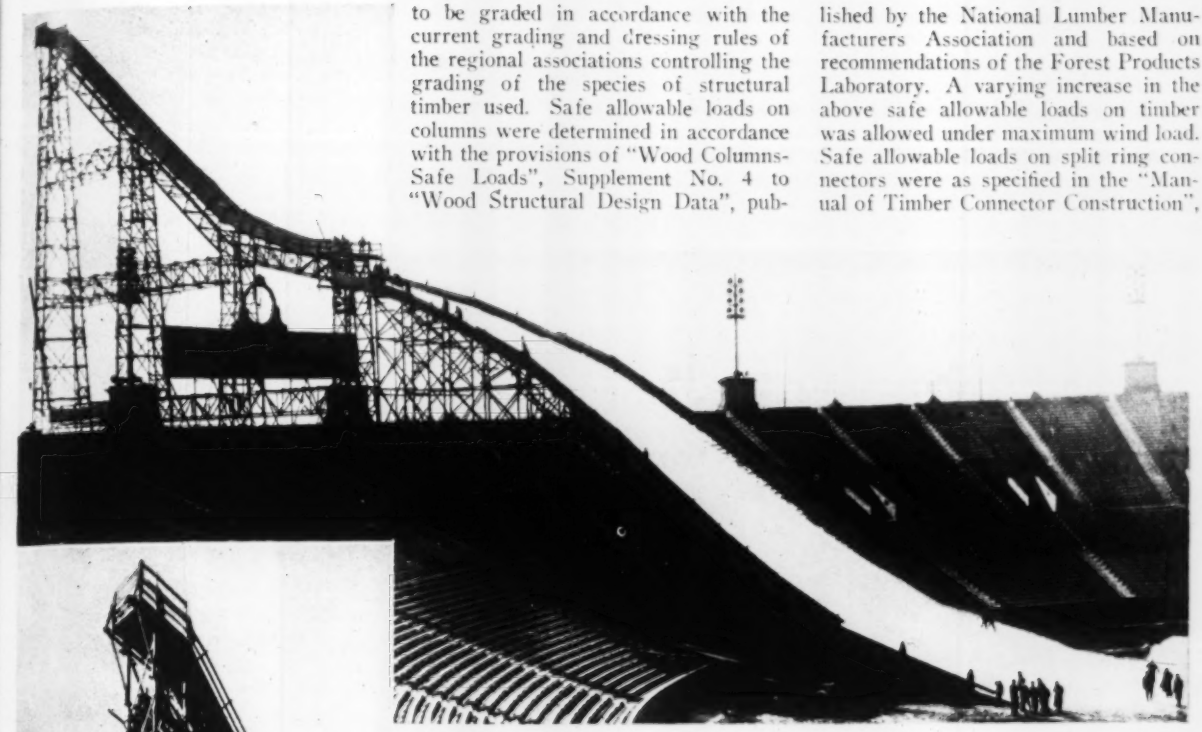
The ski jump structure consists of two sections, a timber tower and truss section outside the stadium supporting a curved runway descending from a height of 180 ft. to an 8-ft jump-off at an elevation of 92 ft., and a fan-shaped curved timber trestle section supported on the steps of the stadium and descending to the ground elevation inside the stadium. This latter section is made up of a series of framed bents spaced 15 ft. on centers and braced in pairs longitudinally to form towers. These towers use 6x6 in. columns, 2x6 in. bracing and 6x12 in. caps, and support 2x10 in. joists spaced 16 in. and 1 in. sheathing. The three towers outside the stadium are respectively 180, 140 and 105 ft. high above the ground while a fourth tower 46 ft. in height rests on the upper promenade of the stadium. All towers were designed free standing in planes normal to the centerline of the ski jump but mutually self-supporting in a longitudinal direction. The following description pertains only to these outside towers and the bracing trusses.

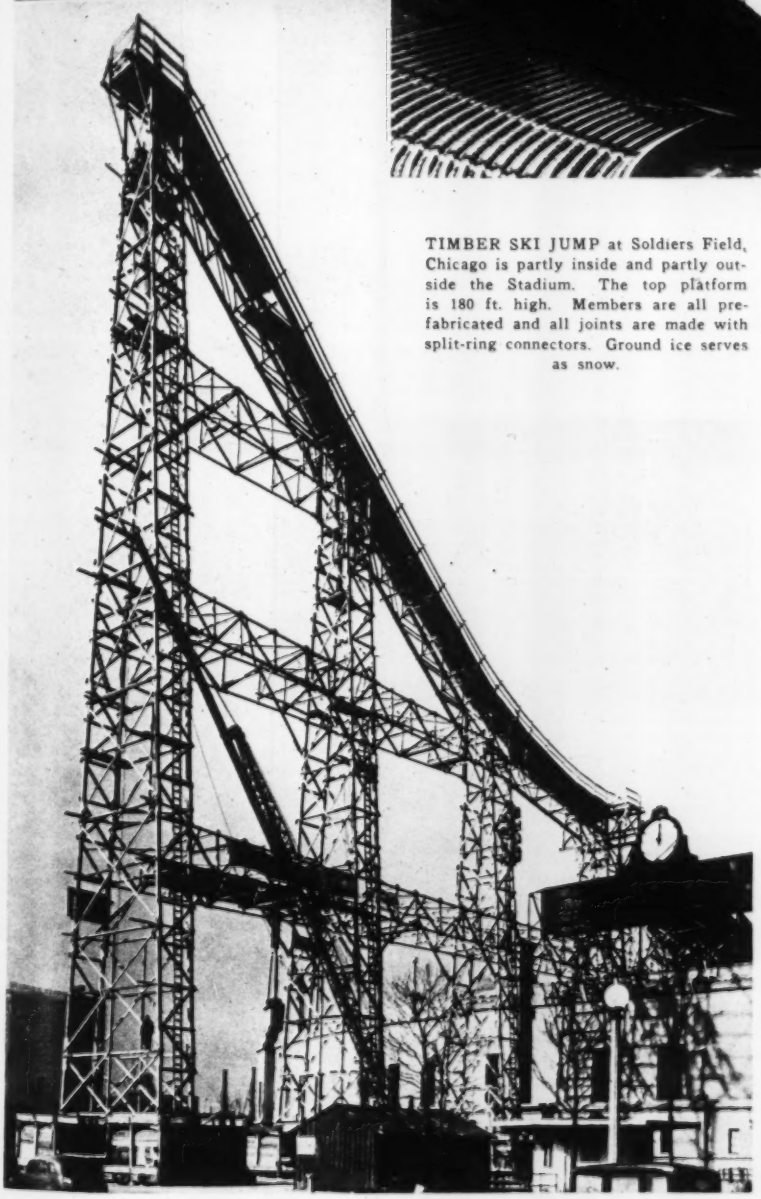
A study of recorded winter wind velocities indicated that the structure should be designed for a wind pressure of 30 lb. per sq. ft. on the windward exposed area and 22½ lb. per sq. ft. on the leeward exposed area of all towers, trusses and the runway. No allowance was made for ice load on the structure because of the high ratio of wind load stress to dead load stress and the improbability of a maximum wind and ice load occurring simultaneously. Provision was made for loads produced by 8 in. of snow on the runway of the tower and truss section and 2 ft. of snow on the lower section resting on the stadium.

It was required that the structure be demountable in order that it could be dismantled after the competition and stored inside the stadium. No part of the stadium structure or its appurtenances could be disturbed and anchorage to the stadium was not permitted.

Preliminary designs and estimates indicated a timber structure would be practical, economical and structurally sound when designed and built with split ring timber connectors. These connectors not only made possible a structure of this magnitude in timber but at the same time provided the desired demountability, since the split rings may be removed from their grooves in the timbers as dismantling proceeds.

The structure was designed for safe allowable loads on structural timber of 1600 lb. per sq. in. in tension and bending and 1200 lb. per sq. in. in compression on short columns, all timber





TIMBER SKI JUMP at Soldiers Field, Chicago is partly inside and partly outside the Stadium. The top platform is 180 ft. high. Members are all prefabricated and all joints are made with split-ring connectors. Ground ice serves as snow.

to be graded in accordance with the current grading and dressing rules of the regional associations controlling the grading of the species of structural timber used. Safe allowable loads on columns were determined in accordance with the provisions of "Wood Columns-Safe Loads", Supplement No. 4 to "Wood Structural Design Data", published by the National Lumber Manufacturers Association and based on recommendations of the Forest Products Laboratory. A varying increase in the above safe allowable loads on timber was allowed under maximum wind load. Safe allowable loads on split ring connectors were as specified in the "Manual of Timber Connector Construction", published by the Timber Engineering Co., Washington, D. C. No increase was allowed for maximum wind loads.

Stone ballasted timber footings

Since the pavement outside the stadium could not be disturbed to place footings below ground, large timber box footings were designed containing sufficient crushed stone ballast to provide a total dead load equal to one and one-half times the maximum uplift produced on the two parallel columns of one face of the tower by the design wind load on the unloaded structure. Trusses inside the boxes attached to the columns transfer this resisting load to the columns and distribute the maximum column and ballast load to the pavement.

Tower details

The towers were designed to produce the maximum duplication of parts. This was accomplished by removing lower panels from the 180 ft. tower to form the 140, 105 and 46 ft. towers. Columns are battered $\frac{3}{4}$ in. per foot of column length, and are 8x8 in. by 20 ft. except the top three panels where 6x8 in. sections are used. Columns in the top panels are variable in length and set vertical at a spacing of 7 ft. 8 in. to provide runway truss connections at variable elevations that would be vertical and spaced a constant distance apart. Columns in the battered faces of the tower are spaced parallel and 6 ft. 6 in. c. to c. Column splices are designed to transfer 80 per cent of all loads through connectors and splice

plates, since these splices must resist tension under the design wind load. Diagonal bracing for the wide tower faces is assumed to act in tension only. A Warren type of bracing of the parallel column faces acts either in tension or compression and provides lateral support to the columns. Horizontal frames are provided in the towers at elevations near the stiffening truss connections.

Lateral support and resistance to transverse bending of the towers is provided at elevations about 40 ft. apart by means of horizontal timber trusses in the planes of the tower columns and by means of top lateral trusses connecting the side trusses. These side trusses are provided with knee braces. Truss-to-tower connections are made to the projecting ends of tower diagonal members which allowed the trusses to be hoisted and connected as a unit with subsequent placing of lateral and cross bracing.

Inclined Pratt trusses are used to support the runway, in this case also the end connections being designed to allow trusses to be hoisted as a unit. Lateral and cross bracing is used in the plane of the lower chord. The posts of these trusses are extended upward to support floorbeams and serve also as handrail posts.

Planks 2 in. thick nailed to the floor beams and bolted to the posts support the snow load and serve as curbs and handrails. Cleats nailed across these floor planks hold the snow in place and make it possible for contestants to ascend the slide along one side of the runway kept clear of snow. These panels of the runway floor may be unbolted from the truss posts and lowered as a unit upon dismantling.

Members shop fabricated

All individual timbers of the tower section were prefabricated at the yards of the Edward Hines Lumber Co., Chicago. All cutting to shape, boring for bolts and grooving for connectors was done at this plant and each timber marked for identification and position in the structure. The timber was then trucked to the site and stacked for erection. The structure required a total of 1913 pieces of prefabricated timber. Approximately 1300 man-hours were required to fabricate 54,000 b. ft. of timber.

Fabrication and erection was done by the Schless Construction Co., Chicago. A crane with a 110 ft. boom worked to the limit of its reach, hoisting complete tower panels and stiffening trusses. Temporary platforms for the workmen were provided at tower panel points. Bracing members were hoisted to these platforms for placing. Stiffening trusses were assembled inside the stadium, carried out, hoisted and connected in place as a unit. Above the 110 ft. level, gin poles were rigged on platforms at the tower panel points. Hoisting of tower panel sections and connecting trusses was done by means of a cable from the crane. Approximately 2,000 man-hours were required for assembly and erection of the 71,000 b. ft. of timber for the tower and truss section.

The use of timber in the project was proposed and promoted by the Chicago Lumber Institute, Leo Kramer, manager. Plans for the lower section of the structure were provided by that organization. The design and shop details for the tower and truss section were prepared by the Timber Engineering Co., Washington, D. C. which furnished the split ring connectors. This design was prepared under the general direction of E. A. Randall, consulting structural engineer, Chicago. General details of the type of structure were conceived by Frank P. Cartwright, structural engineer, Timber Engineering Co. Completion and check of the final design and shop details was done by the writer and P. T. Landsem, structural engineer, Timber Engineering Co.

Protecting North Carolina Beaches Against Wind and Wave Erosion

THIS ACCOUNT *of the method employed for the prevention of wind and sea erosion on 175 miles of sand beaches in North Carolina is abstracted from a paper presented on Dec. 14 before the American Shore and Beach Preservation Association by H. E. Weatherwax, Field Coordinator of the National Park Service, Department of the Interior.* —EDITOR.

TO COMBAT severe erosion on windswept and treeless beaches of North Carolina, several hundred thousand dollars of relief funds have been allotted to the North Carolina Beach Erosion Control Project, on which about 1,000 WPA laborers are employed. Protective work is being carried on along about 175 mi. of the barrier sand beaches extending from the Virginia boundary line to Ocracoke Inlet and including Cape Hatteras.

The primary problem presented to those in charge of the project was to create new sand dunes which could be held in place by planting protective coverings of grasses. Wherever practical, it is intended to plant native trees also on the dunes. The threefold purpose of the project is to strengthen the barrier beach against inroads from the ocean which eventually might obliterate it, to retard wind erosion and protect small villages from inundation by sand, and to restore the area to its original forested condition.

As a result of many experiments it was determined that the most effective type of sand fence for the creation of dunes is the brush fence. This consists of light brush panels, 7 ft. long, held together by battens at top and bottom and erected on posts driven into the sand at the panel joints. The height of the panels varies from 2½ to 4 ft., depending on the location.

It was found that an outer line of dunes between 100 and 250 ft. from the water's edge is the most satisfactory. Under wave and wind action, this location allows for drift accretion resulting from varying directions of sand drift, both toward and away from the ocean. In order to give a natural appearance to the artificial dunes, straight fence was not used, and since it was found that a zigzag fence left exposed elbows of brush which never become completely covered with sand, the sand fences are being laid out in a serpentine plan, taking care to use any existing dunes which still remain.

A single fence will cause the creation of a dune about 20 ft. wide at the base. By successive erection of additional fence on top of this dune and by placing these new fences on alternate sides of the original fence, a total height of about 25 ft. and an ultimate base width of 180 ft. has been achieved. Under some conditions it has been necessary to construct two parallel fences about 50 ft. apart and fill the interval between by groin fences.

It is necessary to plant the dunes with grass immediately after their construction to keep them from being worn away. The grass planting is carried on both on the flat areas adjacent to the dune and up the slopes of the dune itself. Native trees and shrubs are planted after the dune has achieved its ultimate height, but it is impossible to make any attempt to plant trees before some protection has been afforded them by the planting of the grasses and shrubs.

In addition to the dune construction work, a program of research is being conducted to determine the best types of fence to use and on the number and size of sand particles carried by the wind at various heights above the ground under varying conditions.

Topographic and hydrographic surveys of the beach and the off-shore areas are being made in order to determine exactly what results are achieved by the program.

Bay Bridge Traffic and Approach Problems

Planning for 12,000 vehicles per hour on the San Francisco-Oakland Bridge and for handling traffic at either end were major problems in the design of this great trans-bay artery.

By C. H. Purcell, Chas. E. Andrew and Glenn B. Woodruff

Chief Engineer, Bridge Engineer and Engineer of Design, respectively, San Francisco-Oakland Bay Bridge

COMPLETION of the San Francisco-Oakland Bay Bridge and its extensive use by motor vehicles has brought into focus the problem of handling large volumes of vehicular traffic not only on the structure itself but on streets on both sides of the Bay. The six-lane upper deck for passenger cars plus three lanes on the lower deck for trucks and buses have a total capacity of 12,000 vehicles per hour, or 25,000,000 per year. However, to obtain this capacity it is necessary to have a system of approaches that can distribute this volume without blocking the city streets into which the approaches discharge. It is believed, and to a large extent this is confirmed by the handling of the traffic on the opening days, that the East Bay approaches are adequate for this traffic volume. In San Francisco eventually it may become necessary to distribute the traffic to more streets, in which case extensions of the approaches will be required.

San Francisco has been facing a difficult traffic problem, which was only slightly increased by the additional traffic induced by the opening of the bridge. The whole situation now is being studied by the city engineer aided by consultants. San Francisco is bisected by Market St., 120 ft. wide between building lines and 76 ft. between curbs, but on account of four street railway tracks and free parking along the curb lines this highly important thoroughfare has only one free traffic lane in each direction. This situation is made more serious by reason of the difference in street pattern on either side of Market St. To the south the blocks parallel to Market are very long and several of the streets entering Market from this side do not give any thoroughfare across Market. With the completion of the interurban facilities on the bridge and the construction of a street railway loop to the terminal leaving Market St. at First and returning on Fremont, the utility of these streets for traffic bound across Market St. will be reduced. The steep street grades north of Market St. and the unusually large number of street car lines throughout the city add to the complications.

As a result of these conditions, the easiest way of entering the business section north of Market St. from the south is to proceed parallel to that street and cross it as near as possible to one's destination. One of the advantages of the bridge location is that the main approach is 4½ blocks south of Market St. so that the traffic is brought to grade at points where the street traffic is not especially heavy. In addition, the approaches were so laid out as to distribute the bridge traffic to as many points as practicable.

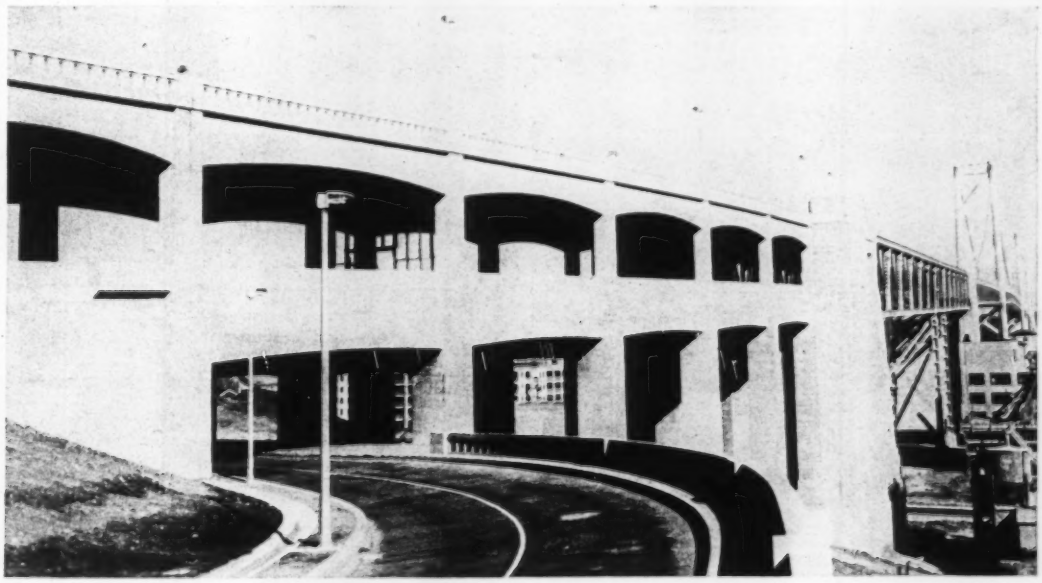


FIG. 1—DOUBLE DECK RIGID FRAMES west of San Francisco anchorage. In the center foreground is the "on" ramp.

This distribution was achieved by building two ramps from the upper deck in addition to the main approach and providing a separate entrance for trucks and buses to the lower deck. The "on" ramp extends from Fremont and Harrison Sts. to the upper deck level at a point a short distance west of the anchorage. The "off" ramp leaves the upper deck level near the same point and reaches street grade at First and Clementina Sts. The main approach extends to Fifth St. between Harrison and Bryant. The truck roadway on the lower deck has a separate entrance from Harrison and Essex Sts. and has been carried through to Folsom St. The two upper deck ramps have a width of 22 ft. between curbs while the 58-ft. width between curbs of the upper deck roadway is carried through the main approach. The truck approach has a width of 40 ft. as against 31 ft. on the bridge. Grades on the main upper deck approach do not exceed 3.60 per cent; the maximum for the "on" ramp is 4 per cent and the maximum for the "off" ramp is 6½ per cent.

Fig. 2 shows the distribution of bridge traffic during an eastbound rush hour, based on an assumed annual traffic of 10,000,000 vehicles, which volume probably will not be reached before 1950. The highest volume of bridge traffic at any Market St. crossing is less than 600 vehicles per hour.

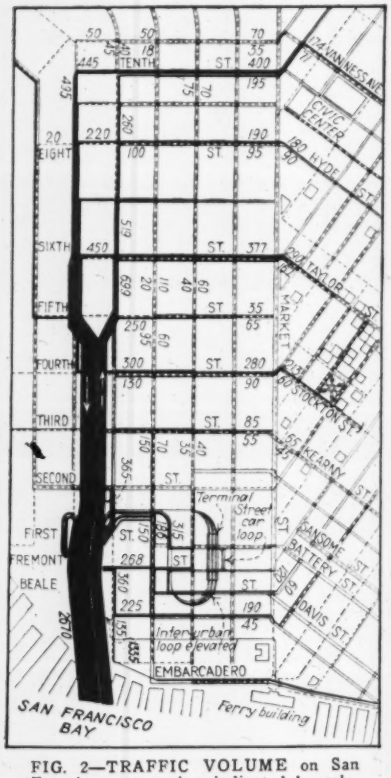


FIG. 2—TRAFFIC VOLUME on San Francisco approaches indicated by relative width of lines. Figures indicate number of vehicles per hour based on 5,000 vehicles per hour in eastbound peak traffic.

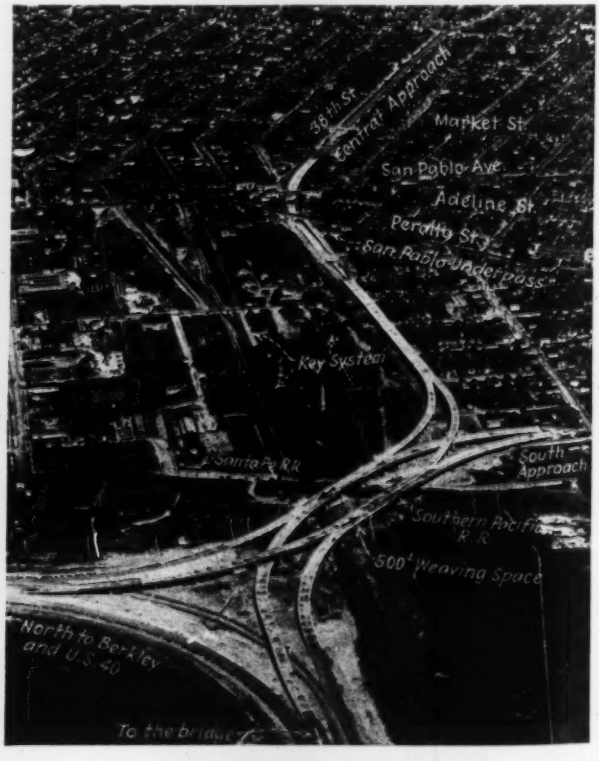
Assuming the total capacity of one of these crossings at 2,000 vehicles per hour, roughly one-third of the total is bridge-bound traffic. Most of this bridge-bound traffic formerly crossed on the ferries so that the increase in volume at these crossings resulting from the opening of the bridge is a very small part of the total.

The width of the lines in Fig. 2 indicates the relative amount of bridge vehicular traffic and the numbers in adjacent streets indicate the number of vehicles per hour based on 5,000 vehicles crossing the bridge in an eastbound peak hour. This corresponds to bridge traffic of 10,000,000 vehicles per year.

In addition to these structural approaches, the work in San Francisco includes the regrading and pavement widening of Harrison St. between First and Second Sts. The city and the state division of highways have cooperated on an extensive program for repairing and setting back curbs on streets near the bridge approaches.

The structures forming the San Francisco approaches consist, in the main, of reinforced concrete rigid frames. Immediately west of the San Francisco anchorage, there are five 65-ft. spans of double-deck construction supported by tall concrete columns. The concrete girders supporting the lower deck are 11½ ft. deep and 3 ft. 9 in. wide. The lower deck reaches ground at the west end of these spans. The upper deck of the main approach is continued on rigid frames

FIG. 3—APPROACHES to the San Francisco-Oakland Bridge. At the San Francisco end (left) the lower deck entrance for trucks and buses is immediately back of the "off" ramp. Oakland approaches (right) include elaborate layout of distribution structures.



FINANCING AND MAJOR CONTRACTS ON THE BAY BRIDGE APPROACHES

A. Items provided for by $6,600,000 legislative appropriations			
Mole fill, east end of bridge to Folger Ave	$ 988,106		American Dredging Co.
Rock wall, east end of bridge to Folger Ave	279,489		Frederickson and Watson
Paving, east end of bridge to Folger Ave	280,904		Hanrahan-Wilcox Corp.
San Francisco approaches	545,000	p	Healy-Tibbitts Const. Co.
Distribution structure	1,181,000		Barrett & Hilp
Folger Ave. underpass	131,801		J. F. Knapp
San Pablo underpass	374,444		J. F. Knapp
Lighting approaches	115,747		Alta Electric & Mechanical Co. and American Building Maintenance Co.
Ashby Ave. connection	31,323		L. C. Seidel
Cypress St. paving — 34th St. to 7th St	135,510		Hanrahan Company
Landscaping 5th St. plaza	16,167		California Nursery Co.
Landscaping east bay approaches	58,000	p	Not yet awarded
Traffic signs, striping, etc	28,000	p	State forces
Engineering	405,000	p	
Property	2,220,000	p	
	$ 6,790,491		
B. Main approach in San Francisco financed by sale of bonds to R. F. C.			
Viaduct, S. F. anchorage to 5th St. abutment	$ 948,300		Healy-Tibbitts Const. Co.
Property	2,211,000		
Engineering	100,000		
	$ 3,259,300		
C. East Bay approaches financed from State highway funds			
Central approach, Market St. to Broadway	$ 119,316		Peninsula Paving Co.
East shore highway to U. S. 40			
Dredger fill Folger Ave. to Camelia St	221,663		American Dredging Co.
Paving Folger Ave. to Camelia St	145,000	p	Hanrahan Company
Lighting Folger Ave. to Camelia St	19,438		State forces
Grading and paving Camelia St. to U. S. 40	241,000	p	Union Paving Co
El Cerrito overpass	262,000	p	J. F. Knapp
Engineering	85,000		
Property	672,000		
	$ 1,765,417		
Total cost of approaches	$11,815,208		

p — Preliminary figures.

with spans of 93 ft. for the street crossings and 68 ft. between crossings. Provision for expansion was made by inserting 38-ft. suspended spans at intervals of about 200 ft. This gives a continuity of construction in so far as appearance was concerned. These suspended spans are supported on one end by bronze expansion plates. The spans in both of the ramps, except for the Harrison and Folsom Sts. crossings, are considerably shorter. In these ramp spans, expansion provisions were made by supporting the ends of the girders on bronze plates.

In construction, the piers were built to springing line grade. Falsework for the girders was supported on piles. Plywood was used in the forms on all exposed surfaces.

East Bay approaches

The system of East Bay approaches consists of the following:

The long paved fill, 1.85 mi. in length extending from the east end of the bridge to the shore line and thence extending northward 2.10 mi. along the water front.

The "distribution structure," 0.5 mi. in length, crossing the Southern Pacific and Key System tracks and connecting the paved fills to the south and central approaches.

The south approach, 1.39 mi. in length, to 7th and Cypress Sts. grading and paving.

The central approach, including the San Pablo underpass 0.79 mi. in length, the grading and paving to Broadway, 0.91 mi., and the future extension of this route, grading and paving, 1.26 mi.

The connection to Ashby Ave. and Ninth St., Berkeley, including the Folger Ave. underpass and the Ashby Ave. connection.

The northerly extension of the East Shore Highway, 5.60 mi. to a connection with U.S. 40, the main highway from the Bay area to Sacramento and points east and north. This extension involved a grade separation over the Southern Pacific tracks at El Cerrito.

Conditions were such that in planning these approaches it was possible to provide for a high degree of dispersion before reaching built up areas. The waterfront of the East Bay cities is cut off by the main line of the Southern Pacific railroad with only one grade separation at 7th St. The state highway department had planned an east short highway extending from the city of San Jose at the south end of the Bay to a point north of the East Bay cities, so located as to bypass congested areas. The location of this highway involved a grade separation over the tracks of the Southern Pacific, Key System and Santa Fe railways at a point near the prolongation of the bridge centerline. It was a natural decision to use this highway as part of the bridge approaches.

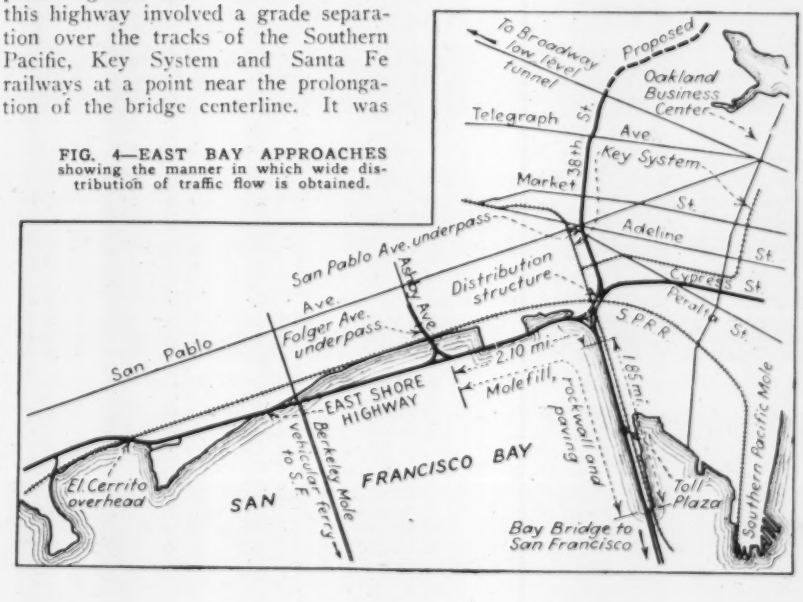


FIG. 4—EAST BAY APPROACHES showing the manner in which wide distribution of traffic flow is obtained.

Mole fill and rock wall

Preliminary borings in the area to be traversed by the approach to the bridge from the east disclosed soft mud extending from low water to depths of 35 to 90 ft. The surface of the hard material formed a system of ridges and gullies. It was apparent that a fill placed on this material would have long continued settlements of considerable amount, varying with the depth of mud. Cost estimates were made on supporting the roadways by a reinforced concrete pile trestle but

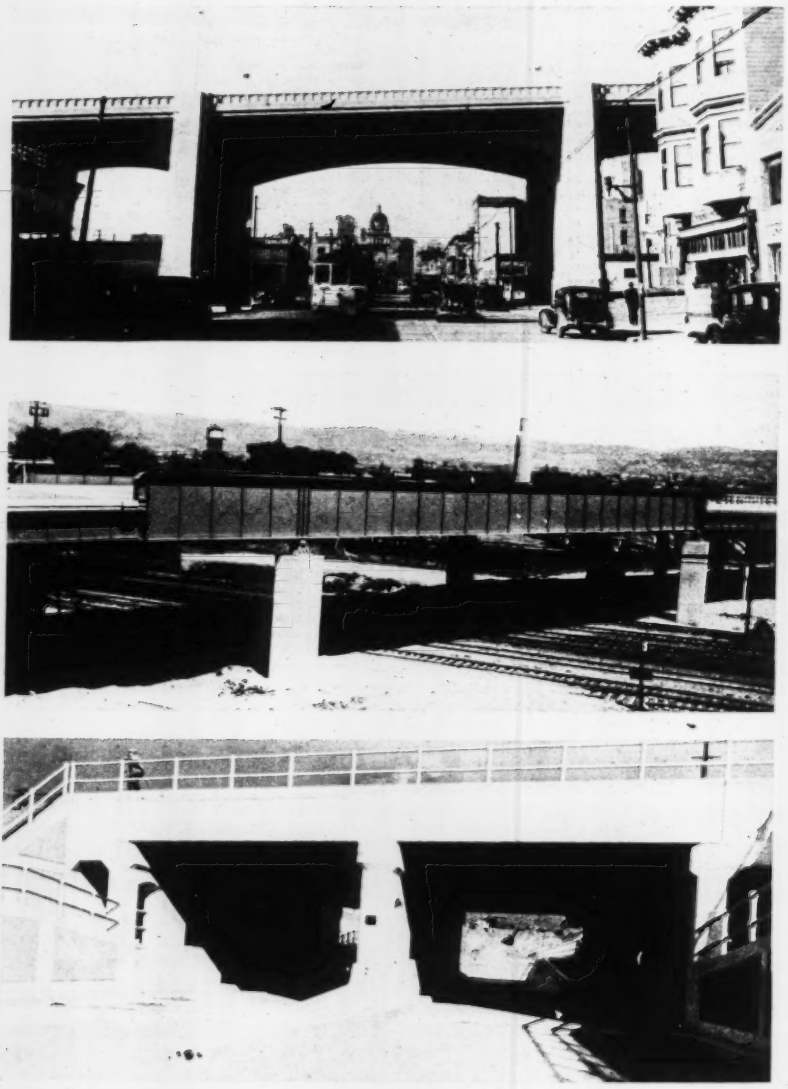


FIG. 5—GRADE SEPARATIONS on Bay Bridge approaches. Top, a 93-ft. span over Third St., San Francisco, with the central 38-ft. section suspended on two cantilevers. Center, steel girders 149 ft. long over the Southern Pacific tracks have 27-ft. cantilever extensions to square the framing. Bottom, Folger Ave. underpass made with precast deck slabs supporting the railroad and with hollow abutments to provide space for sidewalks.

the cost was found to be prohibitive. The proposal to hasten the consolidation of this material by installing vertical sand drains also was considered but was not adopted by reason of cost and because it was too experimental for such a large area.

There have been many instances in which embankments placed on materials of this nature have caused sudden lateral flow of the underlying material. To safeguard against such a movement in this case two precautions were taken, namely, the soft mud was excavated to depths of 15 to 30 ft., the greater depths being used where the distance to solid bottom was greater, and the fill was placed in three stages so that the additional loading came on gradually.

As the fill was placed the northerly slope was retained by a rock wall to protect it from wave action. The south side was retained by the existing Key Route mole. This work included dredging 950,000 cu.yd. of soft material ahead of the fill, the placing of 3,700,000 cu.yd. of hydraulic fill and the placing of 230,000 tons of rock wall protection.

Distribution structure

Unusual conditions at the east end of this fill led to development of a unique type of structure. At this point, the bridge approach meets the east shore highway and also has to cross the Southern Pacific, Santa Fe and Key System tracks. Traffic estimates indicated that the bridge traffic would be divided 25 per cent to the north, 28 per cent to the center and 47 per cent to the south. In addition, the east shore highway will have its own traffic, of which 75 per cent will use the south line, in a volume approaching that of the bridge.

With such volumes of traffic neither highway nor railway crossings at grade could be considered. Some weaving of vehicles travelling in the same direction is necessary, as for example one coming from the north and destined to the south line crossing the path of one coming from the bridge destined to the center line. To make the weaving possible a 500-ft. roadway length in each direction and a width of 52 ft. between curbs were provided. The entire structure proved very satisfactory under the heavy traffic of the opening days.

The design selected provided steel girder spans for the crossings over the roadways and railroads and reinforced construction for intervening distances. Foundation conditions were somewhat uncertain and extremely variable, therefore simple spans were used throughout except that, to secure square framing, several of the steel girders were given cantilever extensions. As an example the through girders over the Southern Pacific tracks have a total length of 149 ft., with a span of 118 ft. and a 27-ft. cantilever.

The crossing contains 2900 piles 40 to 100 ft. long, 2300 tons of structural steel, 1500 tons of reinforcing steel and 29,000 cu.yd. of concrete.

San Pablo Avenue underpass

At the east end of the central approach the route intersects three important streets (Peralta St., Adeline St. and San Pablo Ave.) near a grade crossing of the latter two streets with the Key System. These streets were seriously congested even before the bridge was constructed and a grade separation here was considered essential.

Comparative designs and cost estimates were made of an overhead structure and an underpass. The underpass was found more economical and had the advantage of less interference with visibility conditions on the adjoining streets.

Each street crossing was designed as a box structure with a span of 46 ft.; top and base slabs were haunched from 2 ft. at the center to 3 ft. at the sides. Side walls were 2 ft. 9 in. thick. Between the street crossings, a U-shaped section was used and the structure was designed to withstand the lateral earth pressure. The footing slabs were extended beyond the sidewalls to engage a sufficient volume of earth so that its weight, combined with that of the concrete, would be sufficient to resist the hydrostatic uplift.

The connection from the east shore highway to Ashby Avenue, Berkeley, involved a grade separation, which had to be constructed under traffic, with seven tracks of the Southern Pacific main line railway. For these conditions a two-span structure was provided, with two 21-ft. roadways and two 4½-ft. sidewalks. The base slab was made continuous to support the abutments and the center pier, while the roof slabs were precast.

The railroad tracks were supported by pile falsework while the substructure was being built. Special care was taken to provide water stops which would effectively seal the base slab after the piles were removed. The precast slabs were cast in a yard nearby, and were loaded on cars for delivery to the site. Between train schedules the timber deck of the temporary structure was removed and the precast slabs (26½ ft. long, 6½ ft. wide, 2 ft. 10 in. deep and weighing 36 tons) were placed by a locomotive crane. These slabs were waterproofed by a 5-ply membrane protected by creosoted planks.

Financing

The RFC made it a condition of its loan for the main bridge that the state provide for financing in the amount of $6,600,000 for the acquisition of property for and the construction of all approaches except that from the San Francisco anchorage to the abutment of the main San Francisco approach; the latter was considered part of the main bridge. This amount was appropriated by the legislature from state highway funds. The east shore highway north of Folger Ave. and the extension of the central approach were also built with state highway funds. The expenditures on these structures and the contractors thereon are given in the accompanying table.

The design of the structures on these approaches were made and the construction supervised by the San Francisco-Oakland Bay Bridge organization. The earthwork and pavements were under the direction of the state highway department with J. H. Skeggs, district engineer, in charge.

A $42,500,000 Road System Started from Scratch

Mississippi is building 2,715 miles of paved roads to designs showing notable inventiveness in details and a wide range of alternative sections

THAT MISSISSIPPI is building roads is news. That it is building one of the most closely knit systems of high-type paved roads any of the states have built is news that cries to be told. And the news is worth hearing, for starting from scratch, with only 850 mi. of main road with some type of paving, the present year will see the completion of 2,715 mi. of paved state roads. Moreover the design practice had just as new a beginning and as shown in the text and illustrations of this article it presents much that interests highway engineers.

But it is still more important that there new transport life and pride have been born to the state. After political deadlocks between various governors and their antagonistic legislatures, that for ten years kept highway construction almost at a standstill, transport is now encouraged, not only by the thought of an extensive program of highway construction, (with the improvement in business and financial conditions naturally incident to it) but also by the existence of a hitherto unknown spirit of cooperation between the executive and the legislative branches of the state government.

The passage by the 1930 legislature of the act known as the Stansel Highway Bill, creating an elective State Highway Commission, (one member from each of the three supreme-court districts) provided the state with a modern highway organization, even though it did retain the popular-vote method for the selection of the commissioners. Ample authority and prerogatives were provided but the companion bill to provide the necessary funds failed of passage. This continued to be the situation until last year.

Upon the inauguration of the present administration in January, 1936, it was apparent that a new deal was in sight, which bore fruit in the passage, without a single negative vote, of the 1936 highway act, authorizing $23,000,000 in state highway bonds to be used in matching a PWA grant of $15,000,000. This money with the allotments of regular federal aid-funds for each of the fiscal years of 1936 and 1937, in the sum of $2,325,000 for each year, makes a grand total of $42,500,000; and the requirement is that $33,000,000 of this sum shall be under contract by July 1, 1937. The act authorizes the sale of the bonds either to the PWA, or on the market, at the discretion of the governor and the highway bond commission, composed of the governor, the attorney general and the state treasurer.

For retiring the bonds the act provides that the proceeds from a tax of 1½c. per gallon on all motor fuel be placed in a special account for interest and sinking fund, and, in addition thereto, pledges as much as shall at any time be necessary to be deducted from the remaining 2c. per gallon normally to be distributed to the state highway department for support and maintenance.

Upon the passage of the act there was serious doubt in the minds of many of the highway leaders that the highway department could function on the proceeds from the 2c. tax, but thus far, the tax is more than taking care of the situation. It has been necessary, of course, for the highway commission drastically to curtail the maintenance and equipment budgets, but there has been gradual improvement, and, unless the unexpected occurs, the problem will be more simple in 1937.

Full system planned

In line with the modern administrative act of 1930, the act of 1936 provided a sensible plan for holding the proposed paved road system down to a reasonable mileage and eliminated any chance of a political administration of the program by specifically designating in the act that a certain "priority" be followed, to consist, until amended, of the following:

1. All U.S. routes, as presently designated, with the exception of that part of U.S. 49E between Yazoo City and Tchula, and substituting therefor the state route from Tchula via Lexington to Pickens;
2. Mississippi state route No. 15.
3. Mississippi state route No. 25 between Shannon and Macon

4. Mississippi state route No. 6 between the towns of Oxford and Batesville.

These priority routes have an estimated total length of 2,715 miles. Of this, it is estimated that a total of 850 mi. was surfaced with some type of paving at the time the act became effective.

Having just been through the throes of a very unfortunate situation in connection with the highly sensational $80,000 paving scandal in 1928, the act of 1930 prevented the recurrence of such an episode by providing that the state highway commission adopt four equal and competitive types of paving and that no use be made of any patented types that would require the payment or absorption of any royalties of any kind. While this provision has been the subject of much discussion, and the cause of some embarrassment to some interests, its effect generally has been good and the majority opinion is at least favorable, resulting in its retention in the current program.

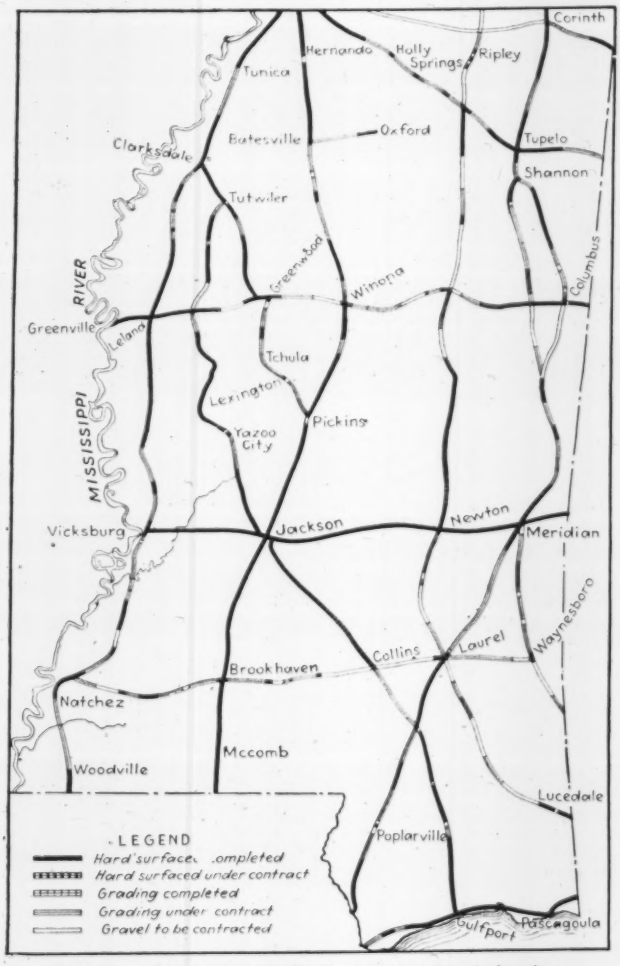


FIG. 1—A HIGHWAY SYSTEM of 2,715 miles designed as one project to cost $42,500,000 elevates Mississippi to high rank among road building states; the map shows progress of the work as of Dec. 19, 1936.

Wide design range

In preparing the standards for the four types, it was necessary that recognition be given to some that were new and untried, at least in Mississippi. The department engineers were familiar with the latest methods for the design and construction of cement concrete pavements, but had little experience with other types, so it was necessary that the asphalt types be patterned after designs that have been found successful elsewhere in America.

The standards being used in the present program therefore are for 20-ft. pavements, as follows:

1. Cement concrete, with either a 9-6-9 in. or 7-5-7 in. Bates type section, fully reinforced with either standard wire mesh or bar mats, with several alternate methods for the construction of the center, contraction and expansion joints.

2. Cement concrete base, with a thickness of 7-5-7 in. carrying one of three alternate types of asphaltic wearing surfacing.

3. Asphaltic concrete base, hot-mix, on an 8-in. compacted clay-gravel base, with any one of three types of asphaltic wearing surface.

The details of the designs adopted are best presented by an ample use of drawings. About three-quarters of the pavement now being built is concrete and two sections are being used: one 7-5-7 in. and one 9-6-9 in. The general plan of the heavier section is shown by Fig. 2. For both pavements bar mat reinforcement and also a section without reinforcement are provided as alternates.

The number of alternates provided in all details is in fact a striking feature of the engineering designs. Variety in this respect is shown particularly in alternative joint designs for concrete pavement illustrated by Figs. 3, 4 and 6. As joint design is today one of the most vital of concrete pavement problems, is least agreed on in principle and structural detail and is most open to new invention the several alternates of the Mississippi plans are depicted with great exactness.

The two types of bituminous pavements differ chiefly in base construction and in the character of the surfacing material. About a quarter of the new paving is of the bituminous type. Fig. 5 shows the design for bituminous concrete top and base on a deep gravel sub-base. The alternates to this design are, in place of the 1½ in. bituminous concrete top, a 1 in. top of limestone or sandstone rock asphalt. Fig. 6 shows the details of asphalt surfacing on concrete base construction.

The state highway department engineers seem to have been thoroughly convinced that the location of a highway is its only permanent element, since practically all routes are being relocated with curves the exception rather than the rule, and when a curve is used, it is rarely sharper than 1 deg. and in many cases, as flat as 20 min. The saving in length being effected already amounts to nearly 200 mi. Bypasses are being constructed for nearly all the smaller towns and most of the cities.

Feeling that width of roadbed is an element susceptible to improvement in the future without lack of economy, the typical sections for grading retain in general, a 30 ft. roadway, with 1 on 4 slopes to a 1 ft. depth of ditch, 1 on 1 or 1 on ½ back-slopes and 1 on 2 and flatter fill slopes, with guard-rail on high embankments. All fill slopes, shoulders and some back slopes are sodded with Bermuda sod; no longitudinal borrow-pits are permitted on the right-of-way.

Complete soil surveys of each project are made prior to the preparation of the plans, so that there is incorporated accurate provisions, by stations on the soil profile, for wasting all unsuitable soil and the use of selected material in the top foot of the roadbed throughout the length of the project. Where no satisfactory material is encountered during the grading, stabilizing material is imported.

Drainage structures consist of reinforced concrete, vitrified clay or cast-iron culvert pipe under the roadbed proper, the contractor selecting and noting his choice in his proposal, with an additional alternate of galvanized corrugated metal pipe for use under side roads and driveways. Reinforced concrete box culverts are of the usual types, except that the size of parapets has been drastically reduced so that no part projects above the slopes of the fill. Small bridges or simple spans in trestles approaching larger structures

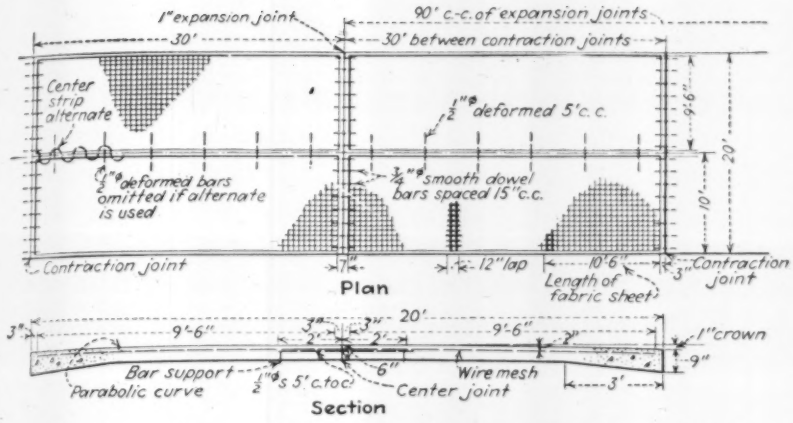


FIG. 2—CONCRETE PAVEMENT has been selected for most of the new Mississippi roads; this plan shows the heavier of the two pavement sections with wire mesh type of reinforcement.

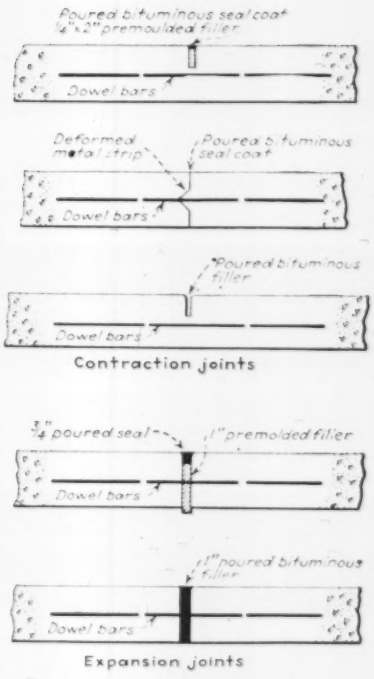
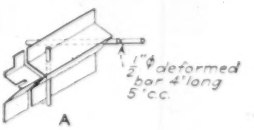
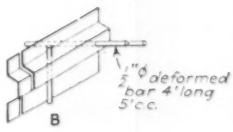
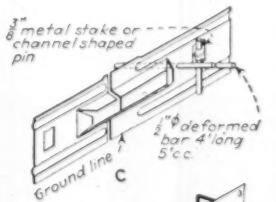
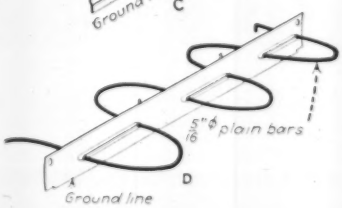


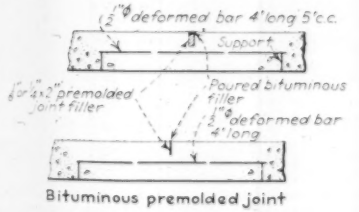
FIG. 4—CONTRACTION and expansion joints covering most of the approved forms are represented in the Mississippi concrete road designs (right).










1/2"ϕ deformed bar 4' long 5'c.c.
Support
1/8 or 1/4"x2" premolded joint filler
Poured bituminous filler
1/2"ϕ deformed bar 4' long
Bituminous premolded joint

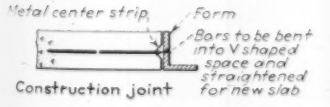


FIG. 3—AMPLE ALTERNATIVES and interesting ingenuity are presented in the center joint designs that the Mississippi highway department engineers have approved.

FIG. 5—A SOLID CONSTRUCTION is sought by a deep gravel sub-base in asphaltic concrete pavement of the cheaper type.

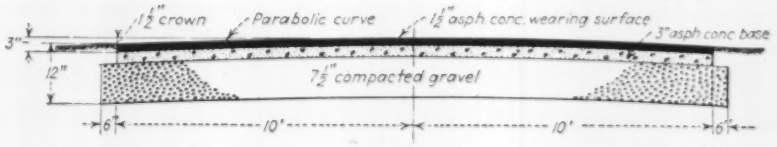
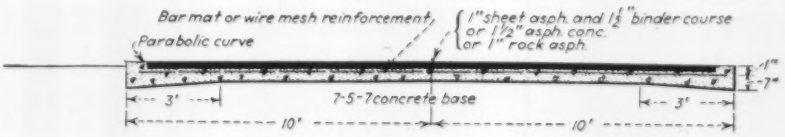
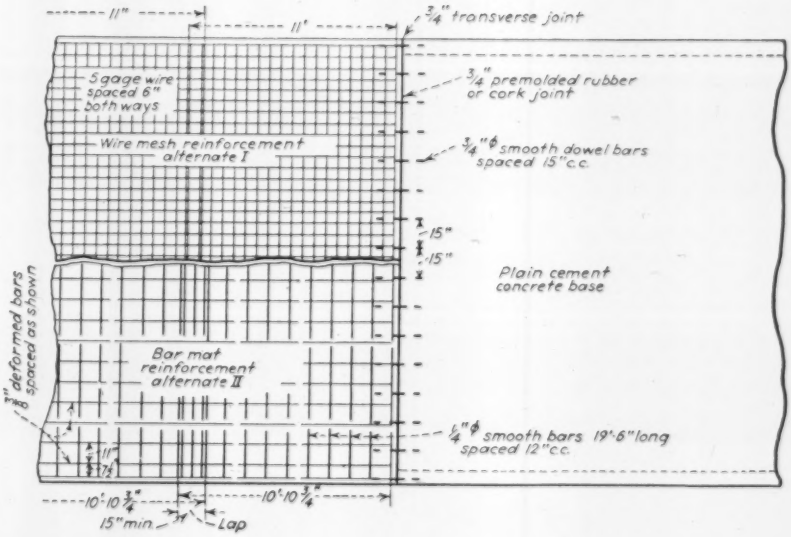


FIG. 6—ASPHALT on concrete base design is notable for the exceptionally high type of base slab that was adopted.





generally consist of creosoted-pine pile bents with creosoted caps, steel I-beam stringers and reinforced concrete floors. The roadway width has been standardized at 24 ft. Larger structures are usually of the cantilever type with special treatment to suit the particular stream. All structures are designed to carry two 15-ton trucks with 30 per cent allowed for impact.

Materials a problem

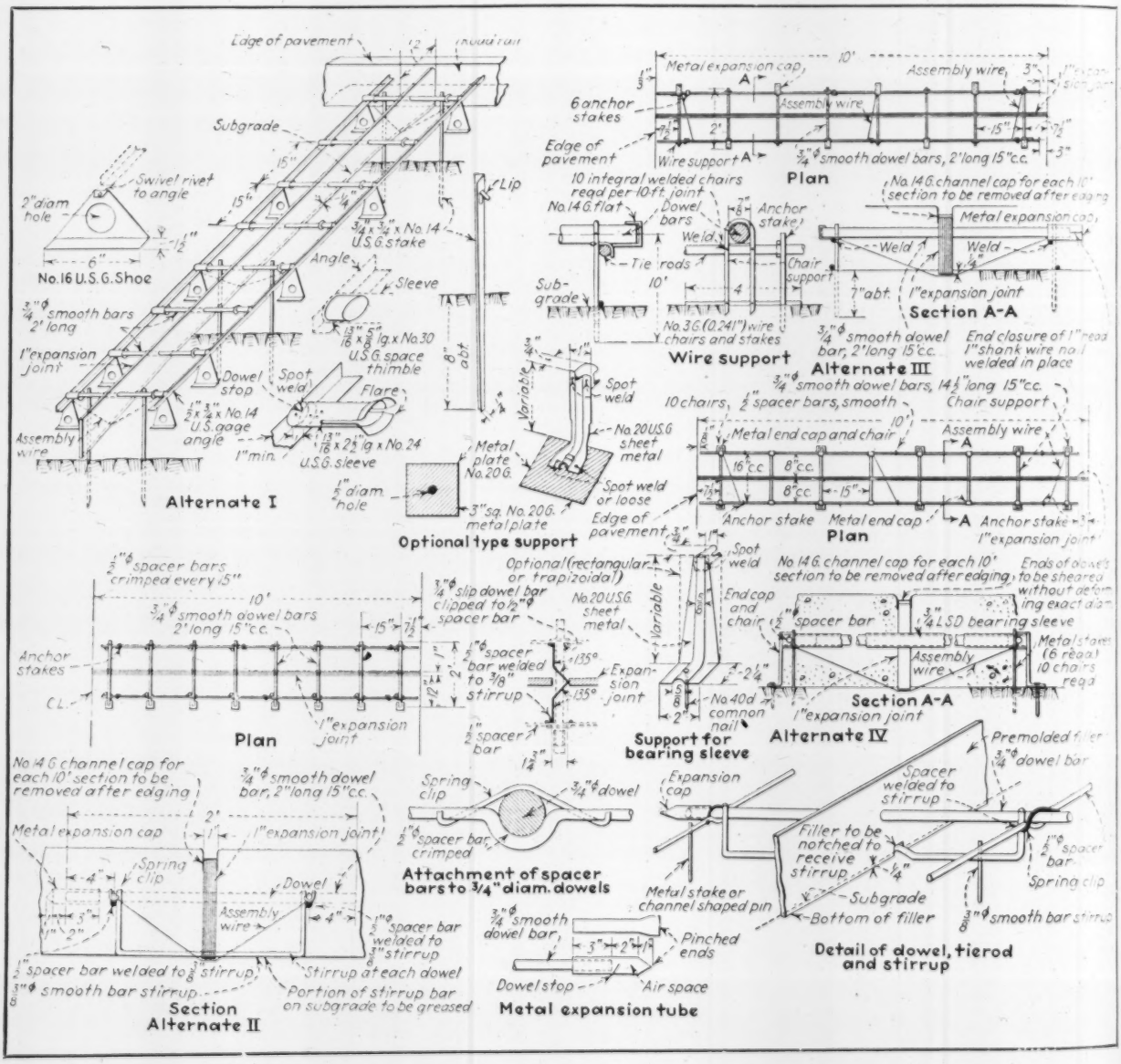
Since materials suitable for the manufacture of the hot asphaltic-concrete surface courses on the concrete base or the asphaltic concrete base and surface courses on the clay gravel subbase, are not found locally at many places in the state, it is seldom that bids are received on any type except cement concrete. Several projects, however, are under contract for the asphalt alternate, the bids on some having been considerably less than for cement.

The aggregate being used for the concrete pavements is being secured largely within the state from the large number of satisfactory screening and washing plants that produce a uniform and dependable grade of hard, flinty, rounded gravel having a maximum size of about 2 in. State inspectors are stationed at all producing plants, every carload of material being tested prior to shipment. A total of 13,000 carloads had been inspected by Dec. 31, 1936.

Concrete mix designs are based on the water-cement ratio, but with a fixed cement-factor of 1.45 bbl. per cubic yard. With an efficient and well equipped soil, asphalt and paving material laboratory located at Jackson and with smaller laboratories at the district offices in Tupelo, Oxford, Brookhaven and Hattiesburg, all material is thoroughly tested before being used. Standard methods and equipment are being used in the manufacture of concrete for pavements, most of the contractors using seven-bag, single-drum crawler-type mixers with two- and three-batch trucks. Only one multi-drum paver is now operating in the state. Curing is being done either with damp earth or, in level country, by ponding. Chemicals are used only in special cases.

The first letting under the new act was held on May 19, 1936, with lettings generally, every two weeks thereafter

FIG. 7—DOWEL ASSEMBLY to insure alinement and fixity undisturbed by concrete placing and operating freedom after construction was sought by a notable variety of designs.



except during December and January. Practically all grading contracts have been awarded, the remainder being held pending the outcome of negotiations now in progress between the department and the Bureau of Public Roads relative to the disposition of the remainder of the funds.

Grading work postponed

Upon the passage of the act setting up the priority system, it was realized that there would not be sufficient funds for the grading, drainage and surfacing with high-type pavement of the entire mileage. The highway commission desires to grade and drain the entire priority system, with surfacing on all the real trunk lines and as far on the secondary routes as the remaining money will permit, feeling that additional funds will be made available when needed. The Bureau of Public Roads, however, has withheld approval of further grading on three routes, suggesting that no grading be done where funds are not available in this program for surfacing.

Progress of work

To Feb. 10, 1937, contracts have been let for grading, drainage and paving at a total cost of about $25,000,000, covering more than half of the entire system. There remains less than 400 mi. to be contracted for some type of construction.

Plans are now being prepared for paving the projects previously awarded for grading, and contracts will be let for these as rapidly as possible at a rate of about $2,000,000 per month. Unless some unforeseen condition develops, the required amount can easily be under contract by July 1, 1937.

Directing officials

The personnel of the highway department consists of the commission, reappointed by the governor under the provisions of an act of the 1937 special session of the legislature, changing the system from the elective to the appointive until the end of 1939, with Brown Williams, of Philadelphia, reelected as chairman, F. L. Linker, of Oxford representing the northern district and Hiram Patterson, of Monticello, representing the southern district. In order that the program might proceed without hinderance, all members of the engineering personnel were reappointed, consisting of E. D. Kenna as director, J. B. Burns, Jr., as secretary, R. A. Harris, as chief engineer, E. B. Cavallo, construction engineer and Sam J. Dalton maintenance engineer, as well as all other staff members throughout the state, for the term beginning January first, 1937, but all members to serve at the will and pleasure of the commission.

Pleasing Appearance Sought In Small Highway Bridge

By Edward D. Smith

Assistant Bridge Engineer, Kentucky Department of Highways, Frankfort, Ky.

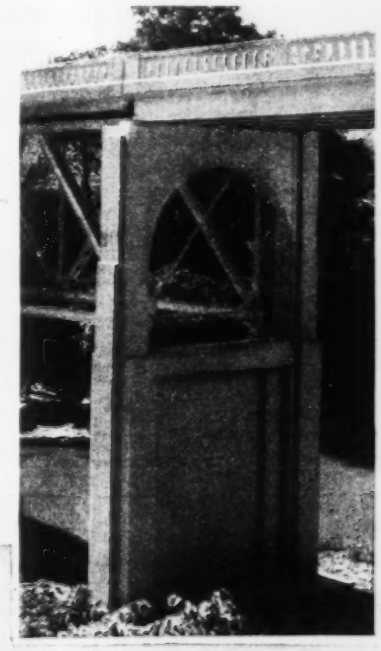
BY GIVING more than usual attention to the architectural treatment of the piers of the new Dix River bridge on the highway between Danville and Lancaster in Kentucky, a pleasing appearance has been achieved in a low-cost structure. The bridge is on a 4-deg. horizontal curve and a 3.057 per cent grade, which complicated the design, but probably enhances the appearance.

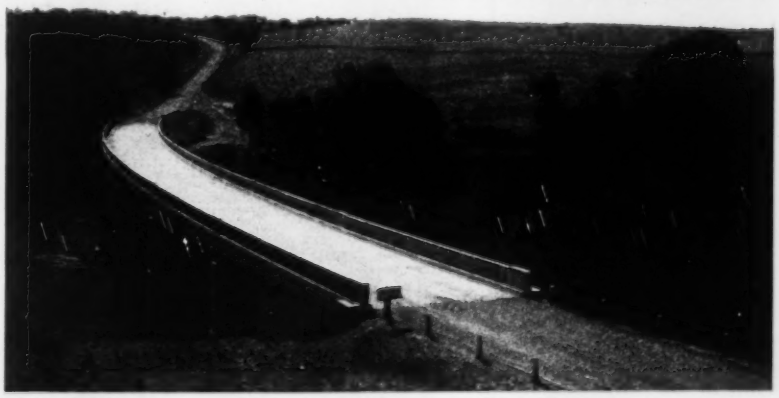
The bridge contains six simple supported spans: The main span is a 150-ft. deck Warren steel truss, and the five 60-ft. girder approach spans consist of 36-in. 150-lb. rolled sections spaced at 4-ft. 10-in. centers. The bridge floor, curbs, handrails, piers and abutments are of reinforced concrete. Hand-rails are of simple, plain design with arch openings between the posts. Open joints are used in each panel of the handrail, and between the handrail posts at all piers. Each pier consists of two columns and the piers at the ends of the main span have a webwall for about one-half their height. Footings for the piers and abutments are founded on solid rock. The bridge floor is superelevated $\frac{1}{4}$-in. in 12-in.

In order to secure the super-elevation on the main truss span, wedge shaped steel bolster plates were inserted between the transverse floorbeams and the top chord on the high side of the bridge. Superelevation on the girder approach spans is obtained by placing steps, which increase in elevation from the low side to the high side of the bridge, on the tops of the caps of the piers and abutments. These steps support bearing plates on which the beams rest. The bridge is designed for H-15 live load, two lanes of traffic.

The superstructure was fabricated and erected by the Vincennes Steel Co., Vincennes, Ind., at a cost of $38,246. The substructure was built by the Shields Construction Co., Hazard, Ky., at a cost of $24,343. The total length of the bridge is 458-ft., giving a linear foot cost of $136.50, and a square foot roadway cost of $5.70.

The plans were prepared by the bridge department of the Kentucky department of highways. Robert Humphreys is commissioner of highways, Thomas H. Cutler, chief engineer, G. L. Logan, engineer of construction, and H. R. Creal bridge engineer.





Deck and pier views of Dix River Bridge in Kentucky

Design Modernization and Cements Dominate Concrete Meeting

Convention of American Concrete Institute in New York provides a forum for discussing new cements, current research and proposed modern design methods

A STRONG TECHNICAL program that emphasized the current attempts to improve concrete structures by special cements, more scientific design and broader appreciation of accepted practice in manufacture characterized the thirty-third annual convention of the American Concrete Institute in New York City, Feb. 23-26. In addition, two extra sessions gave opportunity for detailed discussion of the forthcoming report of the Joint Committee on Specifications for Concrete and Reinforced Concrete.

Some 500 registered for the meeting. J. C. Pearson, of the Lehigh Portland Cement Co., was elected president to succeed F. R. McMillan of the Portland Cement Association. Vice-presidents are John J. Early, architect, Washington, D. C., and Prof. Frank E. Richart, University of Illinois. In line with the Institute's plan to re-invigorate its specification and standards work as it affects concrete design, revisions were made in the bylaws to empower the board of directors to promulgate and carry out a suitable program. Prof. George A. Maney, Northwestern University, was awarded the medal for the most meritorious paper of the year, "Analysis of Multiple Span Rigid Frame Bridges by the Slope Deflection Method." The research medal went to Prof. J. R. Shank, Ohio State University, for his paper, "The Mechanics of Plastic Flow of Concrete." Next year's meeting will be held in Chicago.

Concrete in Europe

THE convention was opened by two papers on European practice by F. R. McMillan and A. J. Boase of the Portland Cement Association who spent two months last year examining structures in France, Switzerland, Germany and England. Europe excels in bridges, the United States in dams. European design recognizes continuity principles more generally than is done in this country. Manufacturing technique is behind America in the general run of work, but nothing to compare with Freyssinet's "treated concrete" is seen in this country. This notable French engineer has made piles and pipe using, in sequence, vibration to aid placement, pressure to stretch the spiral reinforcement and thus increase strength, high-temperature curing, and prestressing of longitudinal bars. A further foreign flavor was given by John C. Ahlers, of New York, who described his experiences in building work in London.

Cement developments

THE federal specifications board will shortly issue four new specifications covering normal portland, high-early-strength, moderate heat and sulphate resistant cements, and the reasons for this radical departure from the long established single standard were discussed by Commander Ben Moreell, C.E.C., U. S. Navy. This paper served as a fitting introduction to a series of papers on cement studies in which the most animated discussion centered on the portland-puzzolans.

As pointed out by Commander Moreell, the federal government confines its specification making to those products for which a substantial governmental demand has developed. On this basis low-heat cements were omitted and also portland-puzzolans, which were also ruled out because of a lack of crystallization of ideas and test data on this type of product. In line with the new A.S.T.M. high-early-strength specification, a definition of portland cement is omitted from the new federal specifications and instead limits are placed on chemical composition, using both oxide and compound composition. So-called grinding agents are permitted if the purchaser asks for them, but in contrast to the A.S.T.M., which provides for their examination by the Bureau of Standards, no provision is made for guaranteeing their harmlessness.

For the Passamaquoddy tidal power project in Maine, extensive studies of concrete materials were made because of such special requirements as salt water and freezing and thawing exposure as well as alternate wetting and drying from extreme tide variations. Unusually dense and sound concrete was mandatory. Capt. Hugh J. Casey, Corps of Engineers, outlined the test program that was carried out to insure such a product when and if the project is built. In brief, suitable aggregates and sand were located in nearby deposits, and after some 45 different cements were examined a sulphate-resistant type was selected in which the tricalcium aluminate was strictly limited to 8 per cent maximum. The cement differs only slightly from the sulphate resistant cement that will be covered by the new federal specifications. A high fineness (not less than 1800 sq.cm. per gram) was chosen since the tests indicated that this characteristic has an important effect in eliminating bleeding.

It was found that portland cements of medium high fineness and low calcium aluminate gave excellent strengths in reasonably short periods, were resistant to magnesium sulphate attack, and had low volume change under both alternate wetting and drying and freezing and thawing. Portland cements with high calcium aluminate, on the other hand, could not withstand the sulphate attack and showed large volume change. The high-early-strength cements were satisfactory except that they presented the problem of dissipation of the heat of hydration. An alumina cement gave excellent performance throughout but also would have given trouble in heat dissipation. A portland-puzzolan cement showed reasonable strength and gave high resistance to sulphate, but performed poorly under alternate freezing and thawing.

Studies made with respect to the use of salt water both in mixing and curing gave some interesting results. Seawater accelerates setting as compared to fresh water but such action is attained at the expense of ultimate strength and durability. Such concrete also is less resistant to freezing and thawing. However, it was indicated that no damaging effects would result from the use of salt water for curing provided that the film of salt deposited on horizontal construction joints was thoroughly cleaned off prior to concreting the next lift.

Portland-puzzolan cements

CONSIDERABLE interest was manifested in the subject of portland-puzzolan cements, which was introduced by a paper on the cement used in the Bonneville spillway dam presented by R. R. Clark, designing engi-

neer, U. S. Engineer Office, Portland, Ore. The paper also gave an original method of computing thermal stresses, using an analysis based on results obtained from tests with the cement and aggregate used. Experience with the portland-puzzolan cement has already been described by Mr. Clark in *Engineering News-Record* (Feb. 11, 1937, p. 219). Although a number of cracks ranging in width from 0.027 in. downward have been disclosed, this does not alter the general conclusion that the portland-puzzolan cement produced an unusually satisfactory concrete. Mr. Clark also called attention to some crazing on horizontal surfaces and to considerable abrasion of the spillway as a result of high water which carried bundles of wire and rock. The condition which caused this debris to be moved back and forth over the concrete will not exist when the dam is completed, according to results obtained in model studies. Some of the crazing resulted from moderate freezing and thawing, indicating in the opinion of Prof. R. E. Davis (University of California), one of the consultants on the work, that portland-puzzolan cement concrete requires a greater degree of winter protection than does ordinary concrete. Professor Davis concurred in the statement that the Bonneville concrete is of excellent quality, pointing out that perhaps the engineers had been lucky in getting a good puzzolan, which is important. In reply to questions, he stated that all of the puzzolan was calcined before use and also that in the manufacture of a small quantity of the cement mineral oil had been used as an aid in grinding in an attempt to reduce the stiffness of the mix; the mineral oil reduced the early strength of the concrete but did not affect the later strength. It was, however, discontinued after a brief trial. Although the abrasion on the Bonneville concrete occurred when some of the concrete was only six weeks old, and might therefore have been expected, nevertheless tests are being carried out on the relative abrasion resistance of portland-puzzolan and ordinary portland concrete.

Further light was thrown on the subject of puzzolanic materials in a paper by Prof. Davis, covering tests made of cements containing fly ash. This material is the finely divided matter resulting from the burning of powdered coal and is collected by precipitators. Some 18 kinds of fly ash from power plants in the East and Middle West were tried. They were largely silica but contained some carbon, and could be regarded as artificial volcanic ash. Their fineness was about twice that of portland cement and the particles were in general spherical in shape. Some 81 portland-puzzolan cements were made with such fly ash and with these cements 5,000 specimens were cast.

The tests indicated that the best fly ash was that containing a minimum of carbon. Cements made with high-carbon fly ash were inferior in every way. Fly ash is used as an admixture with the cement, and intergrinding is not necessary, although it does produce high-early strength. About 30 per cent of fly ash should be used, although Professor Davis suggested that as much as 50 per cent might be used for concrete that would be placed in the interior of a dam. The water requirement in the concrete in about the same as for corresponding portland cement. Although the compressive strengths of the concretes were lower at early ages, they were as much as 1000 lb. per sq.in. higher at 3 months than for concrete made from normal portland cement. The drying shrinkage at the exposed surface up to the age of one year was about the same or slightly less than for normal portland cement concrete. However, five or six inches in from the surface fly ash cement shrinkage was only about one-third as much as for normal portland cement shrinkage. The fly ash concrete proved less resistant to freezing and thawing but more resistant to sodium sulphate solutions. Heat of hydration was less than for most low-heat cements.

Concrete repair

THREE papers covered the subject of concrete maintenance and repair. The work in relining a canal on the Uncompahgre irrigation project in western Colorado was covered in a paper by A. B. Reeves, engineer, U. S. Bureau of Reclamation. The old concrete lining placed about 30 years ago had disintegrated under the action of alkali, settlement of the foundation material, the swelling of the shale foundations in certain places, water pressure and frost action. The old concrete had been made with a high water ratio, and little reinforcement had been used. In much of the repair work a reinforced concrete lining was placed inside of the old canal, care being taken to secure as much bond with the old concrete as possible. In other sections of the canal, where the lining was badly cracked though still in place, Gunite covering was used. A new floor was also placed in a short tunnel.

The Delaware, Lackawanna & Western R.R. Co. has built some of the most enduring concrete bridges in this country, but although maintenance on these structures has been almost negligible in their 20 to 25 years of life, some minor difficulties have developed. These were discussed by M. Hirschthal, concrete engineer of the railroad company. The principal difficulty resulted from inadequate drainage, although crazing and spalling from other causes also occurred. Mr. Hirschthal outlined the methods of repair, which he divided into patching, coating, encasement, and replacement of a member or part of a member. Perfectly clean surfaces, bonding by dowel reinforcing, and the cutting out of all old concrete were found essential to good repair work. Above all, careful curing of patches was necessary.

The third paper presented a large number of conclusions from many years of experience with concrete in a rigorous climate. R. B. Young, testing engineer, Hydro-Electric Power Commission of Ontario, covered the subject very thoroughly in an unusually practical paper. In Mr. Young's experience, transparent waterproofing materials are disappointing in service. There is a real need for such a material that will be effective for a period of years rather than of months. Mr. Young pointed out that the British have been unsuccessful in developing such a material despite many years' trial.

Not much success has attended the use of iron treatments on the Ontario hydro-electric work although Mr. Young cited instances in which he had seen them used successfully. Bituminous treatments do not stand up well when used as paints unless guarded from the sun or mixed with a filler such as asbestos or mica. Emulsified asphalts are better than cutbacks, which give off fumes and will not adhere to wet surfaces. Bituminous mortars are much stronger than straight asphalt. Cement plaster or mortar will seal a wet surface if aided by good workmanship. One of the best means of closing shrinkage cracks in walls is to paint them with raw linseed oil. So long as the walls are not wet when the material is applied, it will be effective for as much as five years. Boiled linseed oil may also be used if it is painted.

Structural cracks can only be repaired by being cut out and filled. A good method is to fill the root of the crack with oakum and cover with cement mortar. Good workmanship and patience are required. Asphalt may also be put in the root followed by oakum and then covered by asphalt.

Patching work is difficult because of the necessity for securing bond in the face of shrinkage. Preshrunk mortar is usually required, which means mixing about an hour before use. Bond may be secured by brushing three to five cement mortar layers on the old concrete. Curing is all-important in securing durable patches.

Vibration of pavement concrete

ONE of the most significant papers of the convention was presented by F. H. Jackson, senior engineer of tests, U. S. Bureau of Public Roads, covering vibration studies of pavement concrete. Following lines similar to those used in the Arlington Road tests of 1931 but with modern equipment,

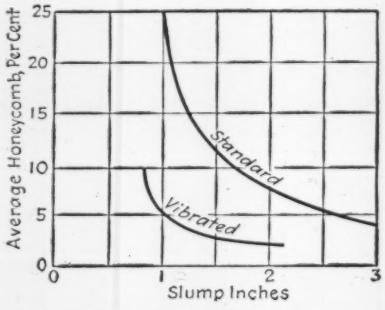
the tests covered 270 sections, 8 ft. long and 10 ft. wide, the equivalent of a half-mile of highway. Four types of finishing machines were used: (1) with vibrators on the front and rear screeds, (2) with a vibrating pan between the screeds, (3) with two vibrators on a hand screed, and (4) with an eccentrically mounted steel tube placed in a trough that was lowered into the concrete. The majority of the tests were made with machines (1) and (2). The effect of vibration was measured by comparing the properties of the resulting concrete with an unvibrated base mix using 6 sacks of cement per yard and a slump of 2½ in. Vibrated mixes were varied in coarse aggregate content, water-cement ratio and sand content. Some concrete was deposited across the pavement and spread with the finisher; in other cases it was spread with the paver bucket and the edges filled in by hand shoveling. Slabs cut from the pavement were tested as beams. Cores and test cylinders gave further data.

Honeycomb resulted mostly along the edges of the pavement. An unusually large amount of honeycomb in a 1-in. slump unvibrated concrete contrasted with practically no honeycomb when the concrete was vibrated. Vibration was found to increase the strength over and above the increase resulting from a lowered water-cement ratio. These results were for 7-in. thick slabs. For 10-in. slabs it was concluded that concrete with slightly more than 1 in. slump should be used to get a minimum of honeycombing. It was also noted that without vibration 1-in. slump concrete is much more variable in strength from day to day than vibrated concrete.

When the coarse aggregate in the mix was increased maintaining the same water-cement and sand cement ratios, the strength was not adversely affected and honeycombing was not increased. When both the fine and coarse aggregates were increased and the water-cement ratio remained the same, thus reducing both the cement content and the slump, the same conditions obtained as when only the coarse aggregate was increased, although honeycombing increased if the sand addition reduced the slump below 1 in. Increasing the sand content gave no advantages either in increased strength or uniformity.

When the cement factor was maintained constant and the water-cement ratio and sand-cement ratios reduced, strengths were greater than for the base mix. When slump was reduced to 0.8 in. by reducing the water-cement ratio to 0.64 the crushing strength was greater but the flexural strength did not change. Honeycombing increased as the mix became drier.

Concrete finished with machine No. 2 seemed to give better flexural strength but the concrete of machine 1 gave better uniformity. There was less honeycombing of the concrete finished with machine 2 except in the 10-in. slabs, where the reverse was true. Neither machine 3 or 4 produced as good strength results as machines 1 and 2. Machine 4 compared favorably,



BY VIBRATION honeycombing in a 1-in. slump concrete may be reduced from 25 to 5 per cent. Stated in another way, slump can be reduced from 2½ to 1 in. without increasing honeycomb.

however, when harsh mixes were considered and it also was effective in reducing honeycomb. Machine 3 was the least efficient in every respect.

Mr. Jackson concluded from the tests that existing specifications for pavement concrete can be modified to utilize vibration by (1) adjusting the proportions to give a 1-in. slump with the same net water-cement ratio as used in standard construction; or (2) adjusting proportions to give the same cement content as for standard construction but with slump specified at 1 in. instead of 2½ in.

Structure design

ALTHOUGH the outstanding event of the meeting from a concrete design standpoint was the presentation of the Joint Committee report, there were several design papers of note. Carlton S. Proctor of Moran, Proctor & Freeman, consulting engineers, New York, discussed recent foundation advances citing and describing work on the Bay Bridge at San Francisco, the New Orleans Bridge, the structures for the New York World's Fair and the Palace of the Soviets in Moscow. This latter structure, to rise 100 ft. higher than the Empire State Building, will be supported by a single row of columns placed in the circular exterior wall. The framing arrangement permits of practically no differential settlement and an annular concrete ring has therefore been designed as the foundation. Situated on stratified soil and rock of varying consolidation coefficients, this foundation presented a design problem of first magnitude. Soil mechanics principles and methods were used extensively. The foundations are about 75 per cent complete.

At the University of Illinois, a series of 22 concrete rigid frame knee members, 8 ft. 9 in. overall, and 12 in. thick, have been loaded to failure to determine the effect of various types of fillets and reinforcing arrangements on their moment resisting capacity and the elastic properties. The L-shaped members were loaded on their ends through special roller bearing shoes. In addition, 8 frames have been subjected to sustained loading for 15 months by means of heavy calibrated springs. The frames tested had no fillets, 45-deg. fillets of 8 and 16 in. widths, circular fillets of 12 and 24 in. radii and in two cases the back corner was chamfered. The principal item of interest in the reinforcement was the use in some frames of 1 and 2 per cent of compression steel. Strains, rotations and overall deflections were measured.

The outstanding conclusion of note was the definite increase in strength obtained through the use of fillets, the wide 45 deg. fillet and the long circular-fillet giving the best results.

Compared with a frame having no fillets, the 45-deg. 16-in. wide fillet gave a strength increase of 12 per cent while the larger circular fillet produced an increase of 31 to 33 per cent. The strengthening effect of the fillets was largely due to the resulting reduction in bending moment and to the slightly increased depth of member at the point of failure.

The elastic properties of the frames as reflected in the measured strains, deflections and rotations were also greatly affected by the fillets, the large fillets increasing the overall stiffness from 50 to 70 per cent. Chamfering the back corners had very little effect on either strength or stiffness.

The relative measured deflections and rotations agreed fairly well with relative values computed by considering the gross concrete sections, neglecting the tensile reinforcement.

The compression reinforcement was very effective in stiffening the frames, although it added very little to the strength (2 to 7 per cent) because failures occurred in the tension steel.

The sustained loading tests have also shown the marked stiffening effects of fillets and of compression reinforcing. After 15 months concrete frame deflections and rotations have increased three to four times the initial values even under rather light working loads. The increase is least when compression reinforcement is present. Photo-elastic studies of bakelite models furnished data on the position of the neutral axis and on locations of stress concentrations, which in the structure itself are greatly relieved by local plastic yielding. The point of maximum tensile stress in the models agreed closely with the point of failure of the concrete frame. Prof. F. E. Richart, who presented the paper concluded that the results indicate that there are possibilities in the more effective use of

materials in rigid frame bridges.

The importance of reinforced concrete in earthquake resistant design was discussed in a paper by J. J. Creskoff, consulting engineer, Philadelphia. An advocate of so-called dynamic methods of design, Mr. Creskoff cited the application of these methods in the new San Francisco Mint and emphasized the efficiency resulting from the use of integrated foundations and of concrete walls, partitions and floors. In the past, seismic activity has occurred roughly in cycles, and Mr. Creskoff ventured the opinion that an active phase of the United States cycle is now being approached. He urged that all buildings, whether tall or of moderate height, be designed according to dynamic rather than static methods. In this way all factors will be taken into account, no fundamental principles will be violated, and the engineer will know for a certainty whether he has a safe design; the statical method, in Mr. Creskoff's opinion, does not give him this assurance.

The convention took no action on the A.C.I. building code, which is continued as tentative for another year. The code committee, however, submitted several revisions. In the spiral-reinforced column formula the coefficient of concrete strength was changed from 0.22 to 0.225, bringing it in line with the Joint Committee report. On tied columns the permissible load was raised from 70 to 80 per cent of that given by the spiral column formula, also in line with the Joint Committee report and in accordance with the committee's earlier views; the vote of the convention last year had caused the reduction to 70 per cent. A simplified version of the design recommendations for flat slabs supported on four sides was also presented (*ENR*, Feb. 18, 1937, p. 268). This is a subject upon which the Joint Committee has deferred action. Prof. Hale Sutherland, stated that flat slab tests were still under way at Lehigh University by the A.C.I. committee.

Joint committee report

TWO sessions of the convention were devoted to presentation and discussion of a progress report of the Joint Committee on Concrete and Reinforced Concrete. The last public appearance of the report before it is issued in its final form late this year or early next, these meetings were well attended and developed high interest.

When this third report of the joint committee is issued it will differ materially from its predecessors of 1916 and 1924. Progress in the art is of course reflected in its provisions. Furthermore its substance is divided into recommendations and specifications. Design provisions are entirely in the form of recommendations, and reflect the principal departures from the 1924 report. For example continuity and elastic frame analysis are accepted fully. New design methods for concrete columns are incorporated and slight modification of flat slab procedure permits more economical use of high strength concretes.

With respect to concrete making, the report places new emphasis on concrete durability in contrast to strength. And most important, perhaps, it provides for alternate specifications, one for jobs where the contractor is given considerable freedom of procedure within certain limits and one in which the engineer specifies the proportions including a minimum cement content. In the one case, the contractor is his own concrete technician, in the other he is merely a builder operating under orders.

Details of the report which covers some 60 pages can only be referred to briefly. Some of them which occasioned comment and discussion are as follows.

Materials—Both normal portland and high early strength cements are admitted and provision is made for the use of special cements. Admixtures are left to the decision of the engineer, a provision which was criticized as not being definite enough to be useful; hardeners and accelerators will also be given special consideration in the final report, it was stated. Aggregate qualities are specified within recommended limits and also within less restrictive permissible limits for those situations where high quality materials are not economically available. Aggregate soundness is made a function of service records so far as possible; in the absence of such records the sodium sulphate accelerated soundness test may be used.

Placing—Recommended practice is given for placing concrete pneumatically, by pumping and by vibration.

Construction Details—Among the new data is information on the use and spacing of expansion joints in long buildings. A specification requirement for bonding at construction joints states that hardened surfaces shall be "roughened." Discussion brought out a desire to prohibit chipping and to substitute sandblasting for this work; sandblasting would be much more expensive. Others urged the elimination of all horizontal joints wherever possible and the protection of vertical joints with copper strips.

Stresses — Requirements are not changed in general although shear and bond values are made slightly more conservative. Five classes of concrete are recognized varying in 28-day cylinder strength from 2,000 to 5,000 lb. per sq.in. and over.

General Design Theory—Plastic flow is not considered to affect the load carrying capacity of members but to aid in more uniform stress distribution by relieving heavily stressed sections. The elastic frame theory replaces the idea that a frame is made up of an aggregation of isolated members. Live loads may be considered as uniform and bending moments computed by assuming (1) alternate spans loaded, with a maximum of three loaded spans and (2) two adjacent spans loaded, others unloaded.

Beams and Slabs—The use of the factor *n*, discarded for columns, is retained in beam and slab design. In utilizing the elastic frame theory for continuous members, there will be no points of inflection, in general, and negative moment may occur all the way across a span; thus top steel may be required generally, and this situation should be recognized. The thickness formula for slabs is modified to permit the economic use of high strength concretes.

Columns—Design methods developed in the A.C.I. column tests are utilized. The formula for permissible load on spiral columns recognizes the use of hoop reinforcement only as a toughening element and as insurance against sudden or complete collapse and utilizes the concrete outside the hooping for carrying load. On this assumption the formulas for spiral and tied columns are the same except that the former is allowed 25 per cent greater carrying capacity because the spiral can carry part of the load if the outer shell should spall off. Several discussors did not accept this reasoning and predicted that adoption of the formulas would rule spiral columns out of consideration on economic grounds; a smaller amount of spiral steel than is permitted is often desirable, it was maintained. Per cent of longitudinal reinforcement may vary from 1 to 8. Both lapped and welded splices are provided for; discussion indicated a belief in the greater efficiency of welded splices.

The joint committee under the chairmanship of A. E. Lindau will continue its studies in the light of the discussion at the meeting and of that expected in writing. Hopes were expressed that the completed report might be available within a year.

Other committee activities

THE committee on research held a unique open meeting in which a large number of members of the audience were invited to present brief statements on work under way or on projects that seem to offer opportunity for study. Some 200 persons attended the session. Prof. M. O. Withey is chairman of the committee.

Procedure permitting the utilization in reinforced concrete design of existing knowledge of plastic flow and volume change was presented in a report, written by Prof. Clyde T. Morris, committee chairman.

The committee on the use of high-early-strength cement in concrete products presented a second report on its tests, which continue to indicate the economic superiority of such cement. Benjamin Wilk, chairman, stated the general conclusion that, on the basis of economy, 70 lb. of high-early-strength cement is the equivalent of 94 lb. of normal portland cement in concrete product manufacture.

Letters to the Editor

Forestry in the TVA

Sir—In discussing the two subjects of silting from non-farm lands and forestation methods of the Tennessee Valley Authority, the article "River and Region" in yours of Dec. 24, 1936, may prove misinforming. It did not clearly distinguish the problem of handling the land now in forest and the separate and distinct problem of stopping erosion on the non-agricultural lands which are not in forests.

About 13,500,000 acres of the valley, or 52 per cent of its area, is now covered with forest. Although for the most part cut over and damaged by repeated fires, yet these forest lands each year come forth in vigorous, fresh, young growth. The watershed protection problem is to see that this fresh growth is given opportunity to develop continuously; this alone will go far toward increasing the capacity of more than half of the watershed to absorb water and to retard runoff. Such forest-covered land practically never erodes seriously.

In addition to watershed protection, the forestry division of the Tennessee Valley Authority is interested in the adequate development of these 13,500,000 acres of forest. These forest lands today produce little or nothing compared to what they can produce if properly managed for timber growth, wild life and recreation. Thousands of jobs will be available when real forestry is practiced on them. Such jobs are not now available.

The second problem is that of preventing erosion on the land once cleared and farmed, but so badly depleted by abuse and soil erosion as to be no longer suitable for agriculture. There are at least 3,000,000 acres of such land, largely in small scattered areas. The forestry division seeks to stop the most serious gully erosion by combined engineering and reforestation methods.

Three years ago, when work started, lack of knowledge of how to do the work cheaply resulted in the building of too many small check dams and the like. This has been corrected so that today the chief structures used are diversion ditches to carry water at low gradient away from the upper end of gullies, and paved water channels to carry such water down to the stream beds below, without creating erosion. Beyond this, the work now done includes the use of various kinds of brush matting, straw and brush mulch, the plowing in of steep gully banks, etc. Soil-erosion prevention and control is primarily a vegetative problem; what engineering work we do is merely to hold the soil long enough to let the vegetation establish itself.

This work, done by CCC forestry camps, first was centered around Norris Lake and Nitrate Plant No. 2 at Wilson Dam. By the end of 1934 the erosion control work around Norris Lake had been so well taken care of that attention could be turned to the erosion problem of the valley as a whole. Today the great mass of the work of our 26 TVA-CCC camps and six side camps is on private lands in five states.

The forestry division accepts requests for this work from interested farmers and land-owners, studies the situation in the field, and, if the problem bears directly on protecting the watershed from erosion, enters into a contract with the owner whereby he agrees to supply materials, teams, labor, and to protect the area planted from grazing and fire for five years. Then the foresters and soil erosion engineers of the forestry division complete plans for the particular area, and the CCC boys are brought in to do the engineering work and plant the trees. Throughout, close controls are maintained with the county agriculture agents and the agricultural division of the TVA.

Along with this work, close cooperation is maintained with the state forest services in a program of education and forest-fire prevention.

Forest Land Management

As to management of forest lands: The 117,000 acres in the Norris Lake Forest, a narrow strip around Norris Lake owned by the TVA, constitute an undertaking under technical administration with a force of trained men who live in or near the forest itself. The area is divided up into forest units to expedite management. Special uses include about 17,000 acres of land set aside for demonstration and experimental work in game and wild life management. On the remaining 100,000 acres timber growing is the primary objective.

The forest as a whole is a much needed demonstration of how foresters manage forest lands for community benefit. The organization is based on supplying permanent part-time work to a selected number of forest workers living on the land itself. We now have 22 of these workers; perhaps 20 years from now there will be as many as 250 to 300 such forest workers and their families making a living in the forest by working part-time and growing a large share of their food on the land.

A broad variety of uses characterizes this forest. We have a real interest not only in soil erosion prevention and control, forest fire prevention and timber cutting, but in addition we have arranged for emergency grazing permits to tide some of the neighbors of the TVA over last summer's severe drought. We are also occupied in developing the fisheries in Norris Lake. We are stocking the area with fish from our hatchery below Norris Dam, we are developing various phases of the wild life and game, and already have our own herd of deer on the area. We are arranging for leases to cooperatives for recreational service, we sell hay-cutting privileges, handle all sorts of boats for private owners, have our own fire patrol and cruisers, haul material and supplies of all kinds down the lake, rent passenger boats, and do a wide variety of business on the lake, all under a technically trained forester, the principal ranger in charge. We have four fire towers, connected by radio.

Primarily the forestry division is a collection of *watershed protection foresters* cooperating very closely with the engineers, the U. S. Forest Service and the state foresters, in respect to control over waterflow. The forestry work of the Tennessee Valley Authority represents one of the unified fronts on which the Tennessee Valley Authority is attacking the whole waterflow problem.

EDWARD C. M. RICHARDS
Chief Forester
Tennessee Valley Authority

Knoxville, Tenn.
January 12, 1937.

Exaggerated Flood Predictions

Sir—The writer wishes to call attention to the need for care in making and publishing flood predictions. During the progress of the flood now passing down the Mississippi River there has been so much exaggeration that many inhabitants along the lower Mississippi became alarmed when there was no cause or need for it. There has never been any water in sight this year to warrant superflood predictions on the Mississippi River except in the vicinity of Cairo. Many predictors apparently lost sight of the low stages that prevailed in the Mississippi River prior to the beginning of the flood. If the Mississippi had been well above low water when the Ohio River went on its rampage, there might have been some cause for alarm.

While the newspapers have been the worst offenders in the matter of exaggeration, the technical press has not been without blame. In this connec-

tion attention is invited to *Engineering News-Record* for Feb. 4, 1937, wherein it was intimated that the Mississippi River waters would spill into the Bocuf and Atchafalaya basins, and that new peak stages were expected as far south as Vicksburg. The writer, due to his former connection with Mississippi River flood-control work, has followed the present flood with interest, and over two weeks ago had concluded that, with the water in sight, the flood below the mouth of the Arkansas River would approximate the floods of 1922 and 1929, the stages of which were in general well below those attained in 1927. Latest reports seem to confirm this viewpoint. Certain gages will of course be materially different from those in the two previous floods just mentioned due to the large number of cutoffs that have been recently made, indications being that the stage at Arkansas City will be 4 and 5 ft. respectively under those of 1922 and 1929, while that at Vicksburg will be about 2 ft. under. At Natchez the cutoffs above appear to be increasing stages, the indicated crest being about 2 ft. in excess of those in 1922 and 1929.

No doubt the excitement of the catastrophe in the Ohio Basin warped the judgment of some of the predictors so that they were unable to see the trees for the forest. The lower Mississippi of course may yet see higher stages before the flood season is over, since the season is still young. It is hoped, however, that future predictions will return to a sane basis.

F. G. CHRISTIAN

Sacramento, Calif.
Feb. 14, 1937.

According to his report in our Feb. 4 issue, pp. 151–152, H. W. Richardson reported from Memphis under date of Jan. 31 that the Boeuf floodway was expected to go into action soon. This contingency was generally feared at the time. Official statements called attention to the fact that rains along the Arkansas might increase the Ohio flood-wave. What stage reduction would be accomplished by the Ferguson cutoffs was not then known. We do not believe that Mr. Richardson's report in any way exaggerated the hazards of the situation.—EDITOR.

Sir—Further to my letter of Feb. 14, I have just noted from a New Orleans paper that the Weather Bureau gage at Vicksburg has been moved and that the flowline at the new gage at a stage of 51.3 is 2.4 ft. below that at the old gage. On this basis the crest of water now in sight may exceed slightly the 1929 stage at Vicksburg. In the most recent issue (Feb. 11, 1937) of *Engineering News-Record* I note that a stage at Vicksburg, exceeding by four feet any previous stage, is anticipated. This statement appears to be in error since the crest of water now in sight will be some three feet under any previous stage when account is taken of the change in gage.

F. G. CHRISTIAN

Feb. 17, 1937.

Vierendeel Truss Bridges

Sir—The article (*ENR* Oct. 1, 1936 p 471) on the first of eight Vierendeel truss bridges to be built in the United States (in Los Angeles) is published 40 years after the invention of this type of truss bridge in Belgium and it is in fact very similar to the bridge at Tervueren which was the first to be built. American engineers will not mind, I hope, my kindly telling them that they are not, in this field, up to the last progress. During the past 40 years we have built about a hundred Vierendeel truss bridges ranging from 100 to 300 ft. in span, in Belgium and in the Belgian Congo for both highway and railway service. In this long period the system has been perfected both from the technical and the constructional standpoint, so that today all other conditions being the same, the riveted Vierendeel truss bridges are between 20 and 30 per cent more economical than the triangulated truss bridges, and the welded Vierendeel bridges are 20 per cent cheaper than the riveted Vierendeel bridges.

The type used at Los Angeles, of 95 ft. span, is of rather heavy appearance and must be rather expensive. Compare it with the Ousselghem bridge, of 136 ft. span and 18 ft. wide, built in 1910, weighing 111 tons (of 2,000 lb.), and costing 31,000 Francs (gold); also with the Bocholt bridge built in 1934, span 167 ft., width 17 ft., weighing 99 tons. (See also *ENR* July 25, 1935, p. 116 and May 14, 1936 p 703 for additional information on Belgian Vierendeel bridges).

In the course of these 40 years, we have built Vierendeel trusses of five different types: (1) with chords parallel; (2) with chords parallel in the central portion; (3) with upper chord slightly curved in the central portion; (4) with upper cord quite curved and outer posts of a certain height; and (5) with upper chord parabolic from end to end. This latter type is the most economical and, in the general opinion of the well-informed, has the most pleasing appearance.

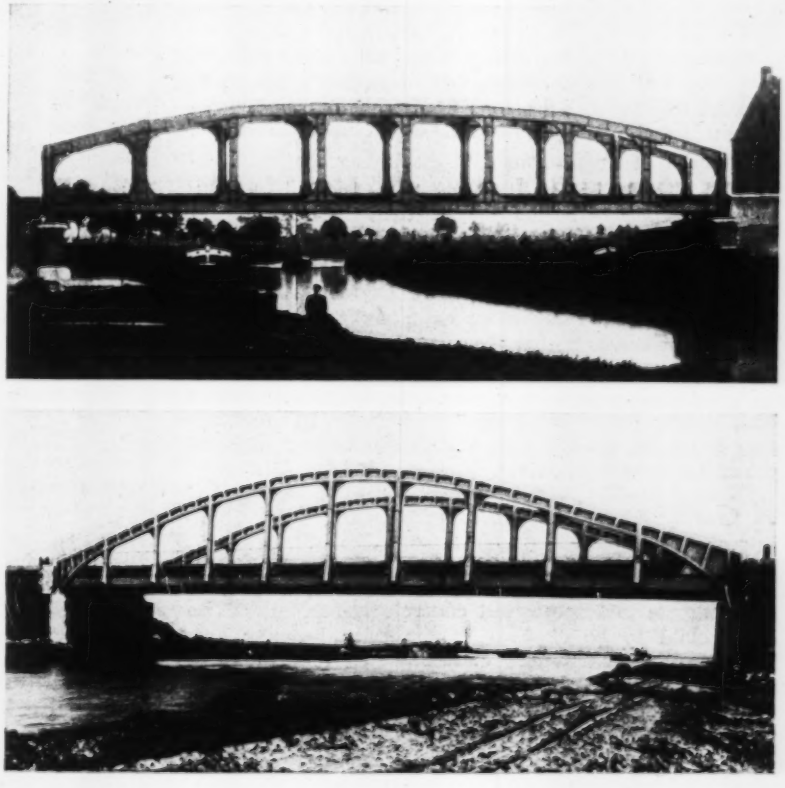
We believe that the circumstance which has checked the use of Vierendeel bridges abroad is their apparent difficulty of design. Now, with a slide-rule and our own method of design, summarized in a few influence tables, a Vierendeel truss of any type and span can be designed within one week, and this without fatigue nor danger of mistakes, because the operations are very simple. (See Volume IV, edition 1935, of our *Cours de Stabilité*).

PROF. A. VIERENDEEL

Brussels, Belgium
Dec. 30, 1936.

EDITOR'S NOTE—Prof. Vierendeel is now 84 years old and on the faculty of the University of Louvain.

TWO EXAMPLES OF VIERENDEEL BRIDGES in Belgium. Above the Ousselghem Bridge built in 1910 and below the Bocholt Bridge built in 1934.



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Editorial offices at 330 West 42nd Street, New York

March 4, 1937

A Look Back

THE ACTIVE roadbuilding program of Mississippi described on a preceding page takes memory back to the days when Illinois, Missouri and North Carolina were laying down statewide road systems financed by unprecedented borrowing. Today in Mississippi the details of financing are a little different (the federal government has a much greater controlling hand) but the fundamental improvement plan is the same—mass construction of a road system. In its resurrection of a now almost-forgotten plan, common two decades ago, the present roadbuilding in Mississippi has a reminiscent interest. This is not true of the technical aspects of the work, however, for its design and construction methods are thoroughly modern. They root in engineering knowledge and practice greatly advanced and perfected in the score of years that have passed since the earlier instances of major statewide programs. The details published indicate interestingly how the Mississippi engineers have interpreted this advanced engineering and applied it in road and pavement structure. Highway engineers will find a wealth of interest particularly in the devices developed for joint construction.

Live Technical Activity

REPEATEDLY during the depression we remarked on the fact that the engineering profession kept up its technical activity excellently well. Yet there has been a vigorous increase since—evident, for example, in the meetings of the American Concrete Institute and the North Atlantic Highway Officials last week. Both meetings were well handled and presented strong programs; but even aside from this they were of notable strength, having large attendance at their sessions and displaying marked seriousness of purpose. Of course it is natural for specialist meetings to be more active than those of general societies; nevertheless comparison with other specialist meetings of some years back shows a real advance. Doubtless the reason is that the engineer's technical problems are emerging more definitely as construction activity revives, and that the change of conditions during the past five or six years makes many of the problems new or more urgent. If this is the correct inference it may be expected that the increase of construction from the present level will bring further intensification of technical interest.

A Guide to Better Concrete

AFTER SIX YEARS OF CONSCIENTIOUS STUDY, work and discussion, the Joint Committee on standard specifications for concrete and reinforced concrete has permitted its brain child to be exposed to the critical public eye. The occasion, last week's convention of the American Concrete Institute, brought forth relatively few barbs of stinging criticism, a fact which the committee can accept as a tribute to its endeavors. Disagreement of eminent authority still exists on the matter of hooped column design and to some extent on the new alternate specification for proportioning, which requires the engineer to assume all risks resulting from inadequacy of the resulting concrete. These and numerous other questions that were raised on details of the design recommendations and specifications will occupy the attention of the committee in the coming months. In the meantime there is the certainty that within a relatively short time the profession will have available a new guide to better concrete. Its desire for more durability will be met by comprehensive information on aggregate selection, by recognition of special cements and by the presentation of crystallized proportioning practice. Its requirements for procedures with truck-mixed and agitated concretes, with transportation by pumps and with placing by vibration will be met. Finally the profession will be led, if not gently pushed, into design thinking along the lines of continuity principles; a gradual weaning from moment coefficients under way for some years, is made final. The third Joint Committee, it seems certain, will add to the heritage left by its predecessors of 1916 and 1924.

But Why 2,000-lb. Concrete?

A CRITICISM which no one saw fit to raise in the meeting that considered the Joint Committee report but which nevertheless should not go unsaid relates to the inclusion of a class of concrete having a 28-day cylinder strength of 2,000 or 2,400 lb. per sq.in. With present-day cements and knowledge of proportioning, mixing and curing, such material is not worthy of recognition in a specification that purports to reflect best practice. And when, as in this specification, a working stress of 800 to 1,000 lb. per sq.in. is allowed on such concrete the inclusion of this material ceases to be merely questionable and becomes absurd. A 2,000-lb. concrete is such a poor material that no more than one-half such unit stresses should be allowed upon it. It is so non-durable under frost action and corrosive water exposure that its use is questionable from an economic standpoint, even if satisfactorily low unit stresses are prescribed. But granted there may still be a demand for it in small bridge and retaining wall footings or in residence foundations, there is no room for it in a 1937 specification. The next higher classification (2,500 to 3,000 lb. per sq.in. at 28 days) is the minimum that should be recognized by a document setting forth acceptable practices.

Beginning to Clear Up

GROWING CONFUSION of thought and opinion on cement quality has been obvious for some years past, but now there are indications that the confusion is clearing up. So long as the trend was for each consumer to add his own special clauses to cement specifications the prospect of improving the level of cement quality was rather dubious. Fortunately, stabilizing factors are now making their appearance. The group of federal specifications covering four distinct grades of cement reflects the opinion of many engineers of good judgment that there is no justification for a great number of different cement types and that a limited range will serve all uses effectively and economically. The commercial conditions that lead the French, for example, to recognize thirty or forty different cement grades have no force in the United States, and under these circumstances

the selection of a well-defined range of types by the Federal Specifications Board is a move in the right direction. Another stabilizing factor is the decision of the cement manufacturers, on the basis of extensive investigations, to adopt the autoclave test as a regular production criterion to protect against unsoundness. It is conceded that present tests do not reliably detect unsound cement. In effect also it is conceded that some unsound cement has been produced and used, a fact that is no particular news to careful observers. Increased stability of cement quality is certain to reduce those consumer complaints that have been a large factor in the demand for new cement types. Adoption of the autoclave test therefore is welcome, and should prove definitely constructive. Incidentally it represents a belated vindication of the attitude of H. J. Force, who pioneered this test a decade or two ago.

Making the Most of Materials

IN THE CURRENT GROWTH of industry and its advance to a higher production level, a distinct trend toward increased efficiency is apparent. More than for many years past one may see in each new undertaking an aim to accomplish the result with less labor and less material, even though venturesome pioneering may be required.

The civil engineer's construction problems have to face this same objective; the present rise in price level only emphasizes its importance. As a matter of fact the demand is already finding response—in the exceptional ingenuity of constructors evident in all current work. For fullest effect, however, increased skill in method and in use of tools should be matched by like progressiveness in the use of materials.

Improved quality and higher stresses are one answer. An obstacle to their introduction lies in the numerous rules and prescriptions that surround civil engineering design, and in the fact that many design practices embody the teachings of long-time experience—though often somewhat obscurely. Against adherence to tradition, however, there is the fact of continued improvement in quality and uniformity of material, as well as better knowledge of forces and more precise methods of analysis. All these justify reduction in the margins of ignorance. Granting that the conservative engineer will always keep in mind the uncertainties of service—the loads that may come on his structure as against the 40 or 80 lb. used in design, the windstorms and settlements that are likely to occur—it is not essential that old working-stress practice should survive merely because it is hallowed by tradition. Higher stresses are a logical sequel to improvement in knowledge and technique.

In another direction, progress should come from fuller consideration of the suitability of a particular material to its service, and the trial of new materials. The building field already has turned to new materials that compete with older ones, and is definitely coming to the point where choice is determined by service per dollar of cost. Other fields are equally open to the entry of new materials. Thus the producer's inventiveness and the engineer's open-mindedness and ingenuity in fitting material to service regardless of tradition are essential factors of advance. Even complete change of structural type may result, as through adoption of steel or slab dams in place of massive dams.

There are possibilities also in more effective use and treatment of materials. Earth in fills is a prominent example, for recent experience has shown that selection and compacting contain possibilities beyond reach even a very few years ago except with undesirable increase of risk. The new fields that have opened to wood construction through the development of timber connectors and plywood also point to opportunities that lie in better ways of handling material.

In various respects, then, the times are especially favorable to thorough study of materials, and with it to a reconsideration of working stresses. Other design practices may also justify reconsideration. For example, where the designer undertakes to use higher stresses, he may find it proper to check the adequacy of the design under increased or emergency loading rather than to ignore the exceptional contingencies of service and relegate them to the safety factor at a lower stress level.

It goes without saying that review of conventional design assumptions is always in order. Standards and rules of practice imply static conditions and are subject to question when technical advance and new efficiency requirements present change of conditions. The civil engineer's art at present is under the same necessity as all other technical arts of rising to a level of more efficient performance, and to this end it must be prepared to reconsider its ways of using materials with a view to making the most of their possibilities.

No Policy Yet

MUCH OF THE CURRENT DISCUSSION indicates the general belief that a definite policy for the sale of Bonneville power has been established by the President's special power-policy committee. Actually no policy has been set; all the committee or the President can do is recommend to Congress what it should do. But even were Congress to accept and write into law the present proposal it would still be far from establishing a definite policy governing the whole matter of the sale of power from Bonneville Dam.

On the matter of power policy the committee's chief recommendations are that preference be given to the power requirements of public agencies and that the terms under which power is sold to private agencies include a cancellation clause for use in case the power is needed for public agencies. But these are academic questions until purchasers of the power can be found; and purchasers cannot be definitely assured until price and sales policies are set up.

On the important question of whether the power will be used to stimulate industrial development of the Portland area by making transmission costs a factor in the sales price, or whether it will be used to stimulate decentralization of industrial development by selling it at uniform rates throughout a wide area, the committee makes no definite recommendation. Similarly, the committee is indefinite on the matter of allocation of costs of the dam between power, navigation and flood control. To what, for example, will the $6,000,000 spent for fishways be charged?

If the orderly development of the lower Columbia River valley is to go ahead as it should, a definite decision on the manner in which Bonneville power is to be sold and at what price ought to be made quickly.

CURRENT NEWS

Rent Subsidy Housing Bill

Wagner-Steagall measure provides federal loans covering entire cost and 45 per cent rent subsidies

A bill to set up a federal housing program under which $1,000,000,000 would be loaned to local housing agencies by the federal government over a four-year period and annual federal subsidies would be given in order to keep rents low was introduced in Congress Feb. 24 by Senator Wagner and Representative Steagall.

The bill resembles the Wagner housing bill which was passed by the Senate last year, except that rental instead of capital grants are provided for and no capital outlay is required of the local housing authorities. It sets up a permanent federal housing agency consisting of a board of three men. The agency would be authorized to issue bonds over a four-year period at the rate of $200,000,000 the first year, $250,000,000 the second and third year, and $300,000,000 the fourth year. These bonds would be issued against the credit of the United States government and the proceeds loaned to state, municipal and county housing authorities for the purpose of constructng low-rent housing. The loans would be repayable over a period of not more than 60 years and would carry an interest rate equal to the going rate of interest on federal bonds.

Annual subsidies provided

In order to insure that the housing to be constructed under the program be available to families of low income, it is further provided that the federal government will make annual subsidies to the local housing authorities. A contract setting forth the amount of the annual grant and separate from the loan contract would be issued on each project at the time the loan contract was drawn up. The annual grant could not exceed 45 per cent of the annual cost of operation of the project. It is required in the bill that no annual grant shall exceed an amount calculated by applying the federal interest rate plus one per cent to the cost of the project. Thus the effect will be to grant the project a free construction loan plus an annual subsidy of one per cent of the total land and construction cost of the project.

Demonstration projects

The federal housing authority would not be allowed to issue fresh contracts for grants of more than $10,000,000 in any one year. The contracts of grants would run for a period concurrent with the loan contracts. Fifty million dollars would be immediately appropriated under the bill to take care of the annual grant for the first four years.

Inasmuch as some states and localities do not now have housing authorities which could begin work immediately, provision is made in the bill for the construction by the U. S. Housing Authority of a number of demonstration projects. These would be built at the request and with the consent of the local governing body, would be limited to one project in any locality, and could not exceed in cost $25,000,000 in any one year.

Financing of cooperative and limited dividend corporations is also provided, likewise with a $25,000,000 annual limit. Loans to limited dividend corporations would be limited to 85 per cent of the cost of the project.

The President is authorized under the bill to turn over to the new U. S. Housing Authority any unexpended balances now available for housing purposes.

Sponsors of the Wagner-Steagall housing bill claim that under its provisions some 250,000 dwelling units could be completed within the four-year period or at a unit cost of about $4,000.

In only 21 states is there legal procedure for the establishment of the local housing authority necessary to receive the federal loans and grants. Enabling legislation has, however, been introduced in 14 of the 24 state legislatures now in session.

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Mississippi Road Program Held Up By Lack of Bids

Contract lettings under Mississippi's $42,000,000 roadbuilding program came to a virtual standstill when the state highway commission deferred opening bids Feb. 23 on nine advertised projects aggregating about $2,000,000. Insufficient bids were submitted, it was stated, to make the bidding competitive. It was the second time within three weeks that letting of contracts had been halted.

Commissioner Patterson of the highway department blamed the failure to obtain bids on the fact that the pavement work on which bids are being asked will not be ready for work orders for a year. A ruling of the federal bureau of roads requires that paving awards must accompany those for grading and drainage. The $42,000,000 Mississippi highway program is being performed with PWA money. The federal ruling arises from the fact that the state intends to use the federal money for grading and paving on certain main highways and for grading only on certain others, the paving on these to be done with state funds.

The bureau is understood to have recommended artificial compaction of graded rights-of-way in order to accelerate placing of pavement, while the highway commission intends to allow an interval between grading and paving for natural compaction of the bases.

On most of the paving projects advertised for letting Feb. 23 the grading work has not yet been completed. Mr. Patterson stated that had the contracts been let, the commission would have refused to issue work orders for paving until the roadbed had settled.

No High Land Values At Grand Coulee

Appeals court disallows claim for power-site value of land used for Grand Coulee dam

Valuation of private land taken for construction of Grand Coulee Dam was decided on Feb. 15 by the U. S. Circuit Court of Appeals, Ninth Circuit, on appeal from a federal district court decision. Affirming the findings of the district court (*ENR*, June 25, 1936, p. 929), the circuit court holds that the private owners of the riparian lands at the site of the dam are not entitled to compensation for the potential use of these lands as the site of a dam. Its decision says, referring to the prior decision of the district court,

> The Court fully and fairly instructed the jury upon every element to be considered for just compensation to be awarded, which includes all elements of value that inhere in the property not to exceed, however, the full, fair cash market value of the property at the time of its taking, fairly and conscientiously arrived at, and not including the element of dam-site valuation. . . . The riparian owner has no property right to the use of the water or the power inherent therein, or the fall and flow of the water for commercial purposes, or any purpose, as against the United States. Chandler-Dunbar, supra. That . . . 'the running water in a great navigable stream is capable of private ownership is inconceivable.' Chandler-Dunbar v. U. S. 53 at 69.

Evidence on the market value of the shore lands at the dam site included testimony to show that no other place on the upper Columbia has the favorable geological characteristics of the Grand Coulee site for purposes of dam construction, and that "it would not be practical to construct a dam anywhere else on the Columbia River which would serve the dual purpose of power and irrigation". The Circuit Court's decision refers to the fact that in a previous case "the Supreme Court held that the rule in condemnation cases is that the most profitable use to which the land can probably be put in the *reasonably near future* has a bearing on the market value". As to probable power site use of the lands in suit the court found that "no proof was produced, no offer was made, of any possibility reasonably near or remote . . . that the land would be or could be so used".

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Two Philadelphians Indicted In Tenement Collapse

Bills of indictment were returned on Feb. 27 by a Philadelphia grand jury on charges arising from the deaths of seven negroes in the collapse of two tenement houses in that city last December. Seven bills, each charging involuntary manslaughter, were returned against Frederic C. Wheeler, vice-president in charge of two tenement houses in that city last December. Seven bills, each charging involuntary manslaughter, were returned against Frederic C. Wheeler, vice-president in charge of the real estate department of the Fidelity-Philadelphia Trust Co., and Abraham Samson, lessee of the houses.

Golden Gate Bridge Accident Investigations Continue

Five investigations are under way in San Francisco to determine the cause of the scaffold failure on Feb. 17 which caused the death of ten workmen engaged in stripping forms from beneath the newly placed concrete floor. (*ENR*, Feb. 25, 1937, p. 313). The Golden Gate Bridge and Highway District, owners of the bridge, the Pacific Bridge Co., contractor, the grand jury, the coroner's jury and the state industrial accident commission is each conducting its own inquiry into the cause of the first serious accident on this great 4,200-ft. suspension bridge. None has yet reported final conclusions but indications still point to the possibility that the hook of one of the four hangers that supported the scaffold from the bridge cross-girders in some way slipped off of its bearing on the bottom flange; failure to insert a safety bolt provided to kep the hook from opening would have made this possible. The hanger disappeared in the waters of the Golden Gate, so that no direct evidence is available.

Operation of the platform

One of the hangers consisting of a steel hook and a cast aluminum caster frame is shown in the accompanying illustration. Briefly the scaffold consisted of a working platform 20 ft. wide and 60 ft. long whose side members consisted of 16-in. 36-lb. steel beams threaded through the caster detail, the top flange riding on the flanged wheels. Four hangers, two on each side, were used. One extra set of two hangers was utilized in moving the scaffold, being attached to the next cross girder forward; the two hangers at the rear were removed as soon as the ends of the 16-in. beams moved out of them. The accident occurred as the scaffold was being moved forward and just after the rear set of hangers had been removed. The scaffold had been in use only one day prior to its failure, having been delivered to the job Feb. 15.

Hanger could have slipped

Evidence remaining after the accident consisted of the two rear hangers, which were undamaged and one of the front hangers, which was broken across the aluminum casting just above the wheels where the tie bolt passes through. The opposite front hanger is missing. If its safety bolt had not been in place the hanger could have slipped off its support and the consequent dropping of the corner of the scaffold would have subjected the opposite hanger that broke to a severe twisting. In a test at the University of California, without twisting or impact, one of the hangers broke (also through the tie bolt holes in the aluminum casting) at a load of 20,900 lb. The scaffold, supported by four of these hangers, weighed about 20,000 lb. Unless there was a flaw in the broken casting, the test indicates that the static scaffold load alone would not break it.

Was safety bolt in place?

Whether the safety bolt was in place on the missing hanger is a question of significance that is not yet answered. The bolt was in place on the broken hanger. On one of the rear hangers, the safety bolt is missing while on the other it was found hanging in one of the two clip angles welded on the hooks to take the safety bolt. The nut was in place on this bolt indicating that at the time of the accident this bolt had not passed through the second clip angle and thus could not have been in place.

Form stripping work has been suspended on the bridge pending replacement of the safety net and such new scaffold design or safeguards as may be decided upon.

HANGER used to support form scaffold on Golden Gate Bridge

GRAND COULEE IN WINTER

GRAND COULEE dam is shown from up-river with Mason City and the aggregate plant in the background. Although this photograph was taken after diversion of the river, it shows the (right) extensive preparations on the east bank that were made behind the protection of the earth dike. Concreting operations had stopped for the winter at the time the picture was taken.

Thirty-seven Million Required for Mississippi Program

A Congressional appropriation of $37,010,000 has been recommended by General Markham, chief of the U. S. Engineers, for completion of the 9-ft. channel program for the Upper Mississippi.

This sum is considered sufficient to complete the 26 locks and dams and would make the total cost for the canalization program $147,217,000. The recommended figure also includes a sum for building another lock at Keokuk Dam, which was completed in 1913 as a private power project. The work under the present program should be completed in 1939. At the present time 24 locks and 16 dams are complete or nearing completion.

Court Upholds Labor Union's Strike Against "Lumping"

The appellate division of the Supreme Court in Brooklyn, N. Y., has reversed a decision of the Supreme Court in Queens, N. Y., which had granted a temporary injunction to the W. F. Construction Co., restraining the President of the New York District Council of the Carpenters and Joiners of America from interfering with the construction company's business.

The construction company stated that after it had completed 60 per cent of an apartment house building in Queens, N. Y., the carpenters were called off the job by union officials May 29, 1936. The union gave as the cause of the action the fact that "lumping" was being practiced on the job. "Lumping" was defined as the practice of contractors furnishing labor on a given job without supplying the materials and supplies to be used in the construction work.

The appellate court, in its opinion reversing the injunction, held that "The right of the union to enforce its by-laws does not depend solely upon the definition of the so-called lumping practice nor whether the plaintiff allowed such practice. It is expressly provided that union members may not work on jobs contracted to be performed without the furnishing of supplies and materials and it is not within the discretion of the court to enjoin the maintenance or enforcement of proper rules."

Vehicle Tunnel to Be Built Under Meuse in Holland

The city council of Rotterdam, Holland, has decided to construct a tunnel under the River Meuse, on which Rotterdam, the largest port in Holland, is located. The cost of the project will be about $7,500,000. The tunnel will have lanes for automobile traffic, bicyclists, and pedestrians.

Road Practices Appraised

North Atlantic highway officials hear condemnations of tax diversion and highway design practices

Nearly 1,000 officials of the highway departments of eleven states and the District of Columbia and engineers engaged in the construction of roads attended the thirteenth annual convention of the Association of Highway Officials of the North Atlantic States in New York City, Feb. 24-26. The convention discussed traffic and accident-elimination problems, the construction of modern traffic arteries and the materials to be used in them.

Present-day roads and methods of maintenance, construction and improvement were condemned by several speakers. The practice of several states of diverting motor taxes from road building to other departments was particularly criticized by James S. Bixby, district engineer of the New York State Department of Public Works, retiring president of the association.

"Eventually public opinion is sure to correct this condition," he said. "Maine, Minnesota, Missouri, Colorado and Kansas already have state constitutional amendments confining motor vehicle taxation to highway improvement. In New York state, for 1937, introduced legislation indicates that diversion of tax receipts is still in the same proportion as in former years. The highway department is allotted but $10,000,000 for maintenance work and $29,000,000 for reconstruction from all sources, including federal aid. There is an estimated motor vehicle revenue of $96,000,000 for the year."

Mr. Bixley also pointed out that the increase of 4 per cent in fatalities in 1936 was less than had been expected. He based his figures on the increase in traffic, and said consumption of gasoline had increased 9 per cent. Connecticut, Maine, New Hampshire, New York, New Jersey and the District of Columbia showed a decline in fatalities, he said.

Dr. Miller McClintock of the Bureau of Street Traffic Research at Harvard University made recommendations for the perfect highway of the future. He said it must be of the "limited" type, referring to the limitation of entrances and egresses, which should be carefully spaced, depending on the needs of communities served.

He placed accident causes in three classifications—those resulting from medial friction, including head-on and mid-road collisions; marginal, those occurring from curb congestion and double parking, and those caused by improper swerving in transit. "There is nothing about the present street system that is not wrong for handling motor traffic," he said.

Colonel Frederick Stuart Greene, State Superintendent of Public Works, welcomed the visitors. He said there would be "no such thing as safety on our highways so long as we continue to license the crackpots we have driving automobiles."

Other papers of general interest were presented by Dudley M. Diggs, General Electric Co., on Highway Lighting; by E. W. James, Bureau of Public Roads, on The Road to Mexico City and South to Panama; and by Jay Downer, consulting engineer, on the New York World's Fair of 1939. The papers by Mr. James and Mr. Downer consisted of offhand talks on a large number of lantern pictures of places and structures. Discussing lighting Mr. Diggs said: "The extra-hazardous nature of night driving is not something which has sprung up over night. Trend curves show that night automobile fatalities have been climbing for a number of years, while daytime deaths show a declining trend. Night accidents claim 60

(*Continued on page* 352)

John L. Savage

Colorado Engineering Council Honors John L. Savage

The Colorado Engineering Council, on Feb. 8, conferred its Gold Medal Award on John L. Savage, designing engineer, U. S. Bureau of Reclamation. The council is made up of local engineering and technical societies and the local sections of national engineering and scientific bodies, fourteen in all.

Mr. Savage has been in the Denver office of the Bureau of Reclamation since it was organized in 1916, at which time he was placed in charge of the designing work there. When this appointment was made he was not new to the Reclamation Service, having started work on the Minidoka project in 1903, later going to the Boise office to work on the design of irrigation structures under the guidance of Arthur P. Davis, D. W. Ross and A. J. Wiley. In 1908 Mr. Savage left the Reclamation Service to be associated with Mr. Wiley in engineering practice but both Mr. Wiley and Mr. Savage continued as consultants to the Reclamation Service and participated in the design of most of the important structures built during the period from 1908 to 1916.

In 1924 Mr. Savage was placed in responsible charge of all the important design work of the Bureau of Reclamation with the title of chief designing engineer.

Government Dams Blamed For Ohio Floods

Claiming that the recent Ohio River floods were caused by government dams built along the Ohio River, a Jefferson county, Ky. grand jury sitting recently in Louisville, asked that direct federal grants be given to compensate Louisville and Jefferson County citizens for flood losses, instead of the disaster loans now being made.

The report said that witnesses had testified before the grand jury that the construction of the dams along the Ohio had raised the bed of the river "about 9 ft." during the last ten years. The report further charged that the dams were constructed for the benefit of private business. Chief witnesses appearing before the grand jury were a newspaper reporter and a representative of local civic organizations.

The jury held that, since the government was responsible for the flood through its construction of the dams, it should take care of the loss to the fullest extent and take steps to prevent a recurrence of the disaster.

The jury advocated abrogation of an agreement made by a previous city administration with the government which waived all damage to the city that might be caused by work being done in the river.

New Jersey Transit Plan Urged By Port Authority

The Port of New York Authority, in a report submitted to the New Jersey legislature in accordance with a request from that body passed at its last session, recommends the establishment of a broad rapid transit system connecting northern New Jersey communities with Manhattan and Staten Island. The initial cost of the project, it is estimated, would be about $187,500,000.

It is recommended that this comprehensive transit system be placed in the hands of a public corporation similar to the Port Authority. It is stated that operation of the system would necessarily rely upon public subsidies.

The plan is based essentially upon extension of the present Hudson & Manhattan Railway. A new rapid-transit terminal would be created in Manhattan at 51st St. in the vicinity of Rockefeller Center, and the Hudson-Manhattan Railway line under 6th Ave. would be extended from its present terminal at 33d St. to the new 51st St. station and thence around through new tubes under the Hudson River to New Durham, N. J. On the Jersey side, the Hudson & Manhattan line would be extended through Jersey City, using the tracks of the New Jersey Central Railroad to Port Richmond, Staten Island.

The plan contemplates that a number of interconnections would be made from the Hudson & Manhattan to the Northern and to the New York, Susquehanna & Western lines of the Erie Railroad, as well as the New Jersey Central Railroad. The report states that these connections, with eventual electrification of all New Jersey railroads, would give access to Manhattan to all railroads with New Jersey terminals.

Authority Completes Plans for Brooklyn-Manhattan Tunnel

Construction plans for a $70,850,000 vehicle tunnel from the Battery in Manhattan to Hamilton Ave. in Brooklyn were submitted Feb. 27 by the New York City Tunnel Authority to Mayor LaGuardia and turned over by him to the city Board of Estimate for study.

The mayor stated that if the Board of Estimate approved the project construction would depend entirely upon whether a federal grant subsidizing the work could be obtained. The tunnel authority's program calls for a toll of 25 cents for the tunnel, and the project, the mayor stated, cannot be made self-liquidating on that basis without a grant of about $30,000,000 from the federal government.

The plan submitted by the Tunnel Authority proposes a tunnel 10,492 ft. long from plaza to plaza and 8,800 ft. long from portal to portal. It would run from the Battery in Manhattan to Governors Island, in the harbor, and thence at an angle to Hamilton Ave. in Brooklyn. Vehicle elevators on Governors Island would provide transportation to that point.

Electrification Contracts Let By Pennsylvania Railroad

The Pennsylvania Railroad has awarded contracts to five companies to do the electrification work on its line between Paoli and Harrisburg (*ENR*, Feb. 18, 1937, p. 269).

The greater part of the work will be handled by McCloskey & Co. of Philadelphia. Other contractors are the Vare Construction Co., the James McGray Co., and Louchheim Brown & McDonough of Philadelphia and the Arundel Corp. of Baltimore.

It is expected that the electrification work will be completed within 18 months.

Irrigation Water Supplies Average About Normal

The Bureau of Agricultural Engineering, in the first of its reports for 1937 on the depth of snow released in connection with irrigation water supplies in the Western States, revealed that, as of the first part of February, conditions in general are favorable. In Arizona, New Mexico, Utah, and southern California depth and water content of the snow indicate supplies of irrigation water will be above normal during the coming year. In northern California, Oregon, Washington, Idaho, Nevada, Montana, Colorado, and Wyoming snowfall is below normal for this time of year but not to any alarming extent. It is possible in all these areas that snowfall during the remaining months of the winter will more than make up for the present apparent deficiency.

Reports from all areas, particularly along the Sierra Nevada Mountains, indicate unusual distribution of snowfall; at high elevations snowfall is considerably below normal, but at elevations of less than 6,000 feet it is abundant and considerably above average. Quite generally, snow is light and dry with low water content. Should these conditions remain unchanged until spring, it is probable that early runoff will be above normal, while that coming during the late spring and summer months will be somewhat below the average over a period of years.

This report is preliminary and may be greatly modified or changed by the snowfalls of February and March which are usually quite heavy in the areas where deficiencies are noted at present.

Connecticut Society's New President

Arthur W. Bushell, whose election to the presidency of the Connecticut Society of Civil Engineers was announced in these pages last week (*ENR*, Feb. 25, 1937, p. 314), was born in 1884 in Providence, R. I. After his graduation in 1907 from Brown University, with the degree of B.S. in C.E., Mr. Bushell spent five years in the Philippines on government survey work and railroad location and construction for the Manila Railroad Co.

Returning to this country, Mr. Bushell then joined the Connecticut state highway department as an inspector on road construction, becoming principal assistant division engineer in 1915 and division engineer in 1917. Since 1931 he has been engineer of contracts and construction, in charge of all highway and bridge construction in the state.

Mr. Bushell's activities in the Connecticut Society of Civil Engineers have included two years' service on the board of directors and service as second and first vice-presidents. He has been active on numerous committees and has contributed several papers to the technical sessions of the society on subjects connected with highways.

Autoclave Test Is Adopted

Cement manufacturers adopt autoclave test of volume constancy for all cement shipped

At a general meeting of cement manufacturers held at Chicago Feb. 18 on the invitation of the Portland Cement Association it was voted to adopt the autoclave test as a criterion of volume constancy, throughout the industry. As soon as the necessary testing equipment can be installed, no cement is to be shipped that shows an expansion greater than 1 per cent in an autoclave test of a 1x1-in. bar either 5 in. or 10 in. long.

The autoclave test as a measure of the soundness of cement was introduced some 20 years ago by H. J. Force of the Delaware, Lackawanna & Western R.R., but it did not find general adoption. Studies of a modified autoclave test procedure have been under way for some years past, and according to a statement by William M. Kinney, general manager of the Portland Cement Association, at a meeting of Committee C-1 of the American Society for Testing Materials on Feb. 23, sufficient test data have been secured to indicate that the test has merit although it has not yet been fully correlated with field experience. Mr. Kinney added:

"By voluntarily imposing on themselves at the earliest practical date this autoclave test for cement, cement manufacturers hope to guard against any possibility of unsoundness in cement not revealed by the present standard tests".

The test procedure adopted by the cement manufacturers is described as follows:

Procedure for Autoclaving Neat Cement Bars

This procedure is based on the use of ¼ x 1 in. bars of either 10-in. or 5-in. effective length.

Mix a neat cement paste of normal consistency in accordance with the methods described in Sections 19 to 22 of "Standard Methods of Sampling and Testing Portland Cement" (A.S.T.M. designation C77–32). Immediately after mixing, fill the mold in three layers, compacting each layer by hand with the rubber glove-protected forefinger. Starting at one end of the mold, work along the bar, reaching the opposite end in 25 strokes. Work along the bar and back hack two times, or a total of four times for each layer. After the top layer has been compacted the specimen should be smoothed off with a few strokes of the trowel, leaving the paste slightly above the sides of the mold.

Immediately after the mold has been filled cover it with damp burlap, taking care that the burlap does not come in direct contact with the specimen. Approximately 2 hr. after molding, the specimen should be given the final troweled finish and the identifying reference numbers inscribed on the surface by means of steel dies. The specimens in the molds should then be placed in a moist closet.

Twenty-two hours after molding remove the specimens from the molds and place them in water at 80° F.

Approximately 1 hr. after removal from molds the specimens, one at a time, should be surface dried with a cloth and immediately weighed and measured for length in a length comparator. After weighing and measuring, specimens should be kept in water until placed in the autoclave at age of 24 hr.

Place the bars in autoclave which has been provided with the proper amount of water; raise the temperature from 80° F. to 420° F. in 1 hr. Maintain the 420° F. temperature for a period of 3 hr., then allow the steam pressure to drop to 0 to 5 lb. gage pressure in 1 hr.

Remove cover from autoclave and allow the bars to cool in the autoclave for 15 minutes. Then remove bars and allow to cool in the air of laboratory for another 15 minutes until they reach a temperature of about 150 to 180° F. during a half-hour period. Surface dry the bars and measure for length and weight.

Examination of many types and makes

(*Continued on page* 352)

Wide World Photo

LONG VIADUCT TAKES RAILROAD TRACK OFF CITY STREETS

THE ELIMINATION of the many grade crossings over the tracks of the Staten Island Rapid Transit in the borough of Richmond, New York City, is one of the large crossing-elimination projects being carried out under the New York state grade crossing elimination program. The mile-long Port Richmond-Tower Hill viaduct shown here is a major element of the Staten Island work. It was formally opened Feb. 25. The railway line, a subsidiary of the Baltimore & Ohio, is used chiefly for rapid transit to and from the ferry connecting Staten Island and Manhattan.

SOCIETY CALENDAR

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual meeting, Chicago, Ill., March 16–18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, spring meeting, San Antonio, Texas, April 21–24.

NATIONAL RIVERS AND HARBORS CONGRESS, annual convention, Washington, D.C., Apr. 26-27.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS, mid-winter convention, Albany, N. Y., March 6.

NEW JERSEY SEWAGE WORKS ASSOCIATION, annual meeting, Trenton, N. J., March 11-12.

NEW JERSEY MOSQUITO EXTERMINATION ASSOCIATION, annual meeting, Atlantic City, N. J., March 17–19.

FLORIDA ENGINEERING SOCIETY, annual meeting, Tampa, Fla., March 18–20.

AMERICAN WATER WORKS ASSOCIATION, INDIANA SECTION, Indianapolis, Ind., March 25–26.

AMERICAN WATER WORKS ASSOCIATION, FLORIDA SECTION, Ocala, Fla., March 30–April 1.

AMERICAN WATER WORKS ASSOCIATION, KENTUCKY-TENNESSEE SECTION, and SOUTHEASTERN SECTION, joint meeting, Chattanooga, Tenn., April 5–7.

GREATER NEW YORK SAFETY COUNCIL, annual convention, New York City, April 13–15.

AMERICAN WATER WORKS ASSOCIATION, CANADIAN SECTION, Montreal, Canada, April 14–16.

AMERICAN WATER WORKS ASSOCIATION, MONTANA SECTION, Lewiston, Mont., April 19–23.

AMERICAN WATER WORKS ASSOCIATION, FOUR STATES SECTION and PENNSYLVANIA WATER WORKS OPERATORS ASSOCIATION, joint meeting, Philadelphia, Pa., April 22–23.

AMERICAN WATER WORKS ASSOCIATION, ILLINOIS SECTION, Springfield, Ill., April 29–30.

LICENSE EXAMINATIONS

IOWA, examinations for professional engineering on March 18–19 and examination for land surveying on March 20, Des Moines, Iowa.

Road Practices Condemned

(*Continued from page* 350)

per cent of the lives lost annually, although only one-fifth the total 24-hour traffic flows during the normal hours of darkness, from 6 p.m. to 6 a.m." Surveys on highways permanently lighted, said Mr. Diggs, prove that such illumination decreases night accidents, and when the result obtained through such illumination is compared with the lives saved by other safety measures, permanent lighting is found to be economical in cost.

Automobile design

In a talk on probable trends in automobile design, W. J. Davidson, technical director, General Motors Corporation, said that the motor car of the immediate future is not likely to introduce radical changes in design. He said the rear engine car, while it presented some features of merit and interest and was receiving intensive study in his own and other organizations in the automotive industry, had drawbacks which he considered serious. "The engine in the rear would give better visibility," he explained, "and might eliminate some engine noise if the car were properly sound-proofed." Floor boards also could be lowered without affecting road clearance, but maneuverability and case of control are vital factors of design, in the interest of safety, and they can only be attained by approximately equal loading on all four wheels.

Technical papers

A number of papers of technical importance call for more special consideration at a later time. They include Concrete Factors and Failures by R. B. Gage, chemical engineer, New Jersey Highway Department; Durability of Concrete by C. H. Scholer, Kansas State College; and Desirable Improvements in Concrete Highway Construction by C. B. Breed, Massachusetts Institute of Technology.

At a special meeting of the board of directors H. H. Temple, chief engineer of the Pennsylvania Highway Department, was elected president; Francis J. Whalen of the Connecticut Highway Department, vice president, and A. Lee Grover of the New Jersey Highways Department was re-elected secretary and treasurer.

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Autoclave Test Adopted

(*Continued from page* 351)

of cement for volume change has revealed large differences in expansion under continued exposure to water. When the rate of expansion is large it is usually progressive and the cement proves unsound. The factors responsible for this condition are not yet fully understood. The regular use of the autoclave expansion test, however, will eliminate the cases of excessive expansion and will probably lead also to progressive reduction in variation of expansion in commercial cement practice.

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Obituary

ERNEST LUSH, who had been assistant city engineer of Detroit, died Feb. 26 in that city at the age of 51.

ELMER T. KIRK, 60, who formerly served with the U. S. Engineers, died in Omaha on Feb. 20.

JAMES M. KILEY, for many years a contractor in Boston and for the past two years retired, died in Boston Feb. 24 at the age of 75.

HENRY H. HAWKINS, president of the H. H. Hawkins & Sons Co., building contractors at Newton, Mass., died in that city Feb. 20 at the age of 69.

BERNARD P. SCANLAN, building contractor on many government and bank

buildings in Alberta and Saskatchewan, died Feb. 17 at the age of 58.

EDWARD W. SMITH, for many years before his retirement in 1931 assistant to the chief engineer of the Seaboard Airline Railway, died in Norfolk, Va. Feb. 13 in his 78th year.

FRANK MESSER, president of Frank Messer & Sons, Inc., general contractors of Cincinnati, died recently in that city. Mr. Messer had built many of the larger buildings in Cincinnati.

WILLIAM A. DREW, supervising engineer in the New York City department of water supply, gas, and electricity for the boroughs of Brooklyn and Queens for the past 18 years, died last week in New York city at the age of 64. Mr. Drew had been connected with the city department since 1897.

HENRI DESSAULLES, 58, engineer for the Shawinigan Water & Power Co., died in Shawinigan Falls, Que. on Feb. 21. Mr. Dessaulles, a graduate of the Ecole Polytechnique at Montreal in 1904, was engaged in railway construction before his connection with the Water & Power Company.

LAWRENCE W. BENTLEY, supervisor of the division of operations in Elmira, N. Y. for the WPA, died there Feb. 23. A graduate of Union College in 1912, Mr. Bentley had been employed by the American Bridge Co., the Chicago Milwaukee & St. Paul Railroad, the Barge Canal Commission, and the Western Electric Company.

EMIL TRANAAS, assistant chief engineer of the Koehring Co., Milwaukee, Wis., died Jan. 12, 1937, aged 40. Educated in Norway, Mr Tranaas entered the employ of the Koehring Company immediately on coming to the United States in 1919. He had been assistant chief engineer since 1933, specializing in the design and development of concrete mixers and pavers.

RODERIC PEARSON, highway bridge engineer for the U. S. Bureau of Public Roads, died Feb. 4 at San Francisco, Calif., aged 43. Mr. Pearson graduated in civil engineering in 1916 from the Oregon State Agricultural College and joined the Bureau of Public Roads in 1918 as an assistant in the bridge section. He has been connected with the Bureau since that time except for a few months army service in 1918.

LAYTON F. SMITH, Baltimore consulting engineer, died Feb. 19 in Baltimore at the age of 66. A graduate of the mechanical department of Maryland Institute, Mr. Smith, after several years work for the Baltimore Belt Railroad on the Belt tunnel, worked with Frederick H. Smith on bridge construction in Baltimore, and later did similar work as well as general municipal construction for the city of Baltimore. After service in the Spanish American War and brief connections with various engineering firms, he became associated in 1904 with the Trussed Concrete Steel Co. as engineer-representative, remaining with that concern until 1914, when he began private practice in Baltimore specializing in reinforced concrete design and construction.

LARGER AWARDS FOR THE WEEK

Pulp mill, Soundview Pulp Company, Everett, Wash.	$1,300,00
Factory, Atlas Powder Company, Wilmington, Del.	$2,500,000
Administration building, University of Chicago, Chicago, Ill.	$500,000
Addition to museum, New York Historical Society, New York, N. Y.	$1,000,000
Five sound stages, Metro-Goldwyn-Mayer Studios, Culver City, Calif.	$550,000
Garage for Department of Sanitation, New York, N. Y.	$793,000
Air conditioning U.S. Capitol Bldg. and Senate Office Bldg., Washington, D. C.	$2,747,000
Highways, Nevada	$611,000
Control gates for Marshall Ford Dam near Hughes, Tex.	$1,786,000

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Mar., 1937	225.25	108.18	Feb., 1937	181	79
Feb., 1937	223.45	107.41	Jan., 1937	167	73
Mar., 1936	201.20	96.71	Feb., 1936	176	77
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50

CONTRACTS
(Thousands of Dollars)

	Weekly Average Mar. 1936	Prev. 4 Weeks	Week Mar.4 1937
Fed. Government	$1,985	$3,643	$5,971
State and Municipal	20,702	17,720	9,391
Total public	$22,687	$21,363	$15,362
Total private	14,237	25,936	16,763
Week's total	**$36,924**	**$47,299**	**$32,125**

Cumulative to date:
1936 (10 weeks).....$486,870,000
1937 (9 weeks).....$394,399,000

Note: *Engineering News-Record* reports waterworks and earthwork, reclamation or waterways projects of $15,000 and over in size; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000 and over. The figures above represent the volume of contracts and large force account projects throughout the U. S. that are of these minimum sizes or over.

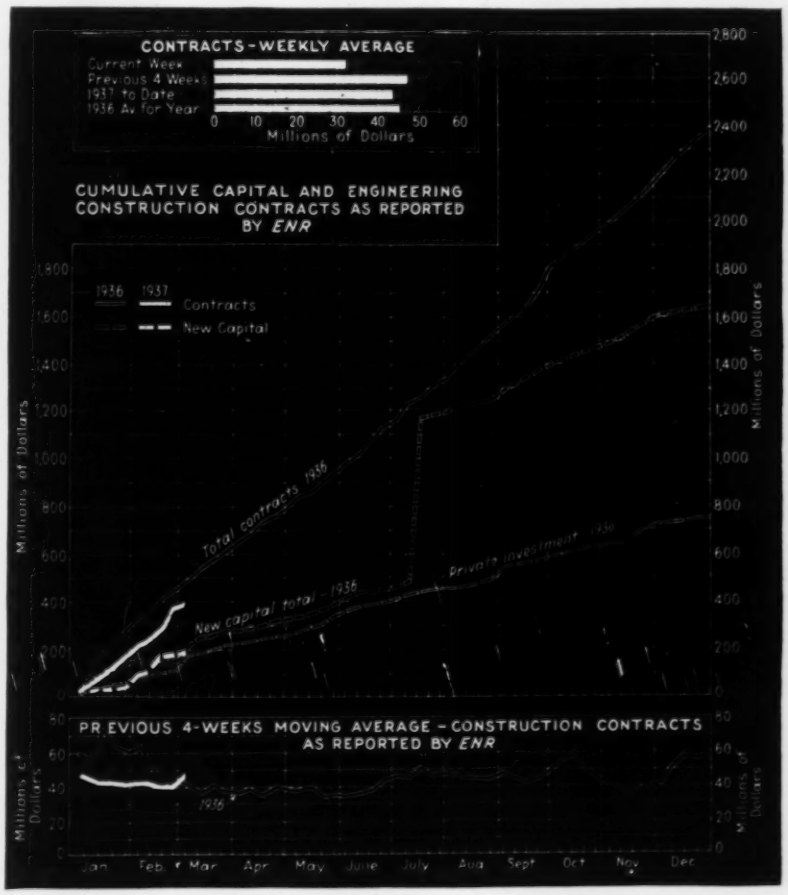
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1937	Week Mar. 4	Cumulative
Private investment	**$6,323**	**$193,952**
State and municipal bonds	3,623	126,249
Corporate securities	2,700	67,703
Federal financing	$45,050	†$40,875
PWA non-federal Projects	45,050	†$40,875
Total non-federal	**$51,373**	**$234,827**
Federal projects	.....	.....
Total	**$51,373**	**$234,827**

Cumulative to date:
1936 (10 weeks).....$225,643,000
1937 (9 weeks).....$234,827,000

Note: These figures include private bonds and stocks sold for new construction purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA construction appropriations.

† Includes transfer from federal to private investment financing through sale by RFC of PWA bonds.


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1937 to Date
1936 Av. for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936 1937
Contracts
New Capital
Total contracts 1936
Private investment 1936
New capital total 1936
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

BUSINESS SIDE OF CONSTRUCTION

February Awards 15 Per Cent Over 1936 Private Construction Gains 146 Per Cent

FEBRUARY engineering construction awards, the highest for any February since 1930, total $189,187,000. This volume is made up of private, $103,745,000, and public, $85,452,000, including $7,444,000 in federal awards, and compares with the January total, $173,077,000; private, $71,252,000; public, $101,825,000, of which $12,145,000 is federal. The corresponding volumes for February 1936 are: total, $164,499,000; private, $42,278,000; public, $122,221,000, including $9,872,000 in federal.

The weekly average for February, $47,299,000, shows a gain of 9 per cent over January. Private construction awards averaging $25,936,000, gained 45 per cent over last month and 146 per cent over last February. The gain over January is due to the Pennsylvania Railroad electrification program which increased the unclassified average 308 per cent, and to the commercial building weekly average, $5,870,000, a 33 per cent gain. Other classes of work are lower than last month, streets and roads by 14 per cent; public buildings, 27 per cent; industrial buildings, 55 per cent; bridges, 26 per cent; waterworks, 10 per cent; sewerage, 55 per cent; and earthwork and drainage, 1 per cent.

Compared with the February 1936 weekly average, $41,125,000, this month records a gain of 15 per cent. Increases in commercial building, 115 per cent; earthwork and drainage, 126 per cent; and unclassified construction, 273 per cent, are responsible for the gain. Other classified averages are lower, streets and roads by 32 per cent; public buildings, 51 per cent; industrial buildings, 5 per cent; bridges, 22 per cent; waterworks, 23 per cent; and sewerage, 63 per cent.

The Middle Atlantic states continue to hold their lead in construction volume, with a gain of 93 per cent over January, and 125 per cent over February 1936. Far West reports a gain of 22 per cent over January, and is the only other section to show an increase over last month.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY *ENGINEERING NEWS-RECORD* IN FEBRUARY, 1937

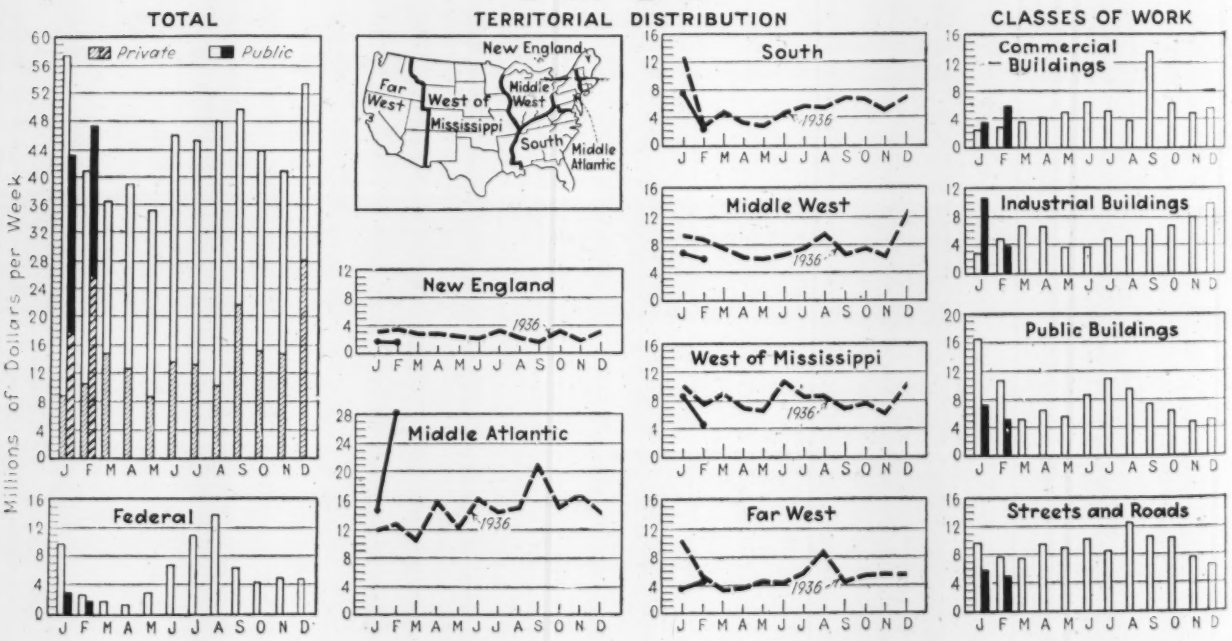
Engineering News-Record *reports projects of the following minimum costs: Water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States February 1937	United States Two Months 1937	United States Two Months 1936	Canada
Public Works										
Waterworks	540	6,353	469	941	708	281	9,382	19,862	30,086	111
Sewerage	52	1,525	299	2,480	402	104	4,862	15,631	36,559	60
Bridges	703	1,925	2,383	2,059	1,696	31	8,797	19,381	31,048	.....
Earthworks and waterways	.....	4,463	131	2,281	1,476	446	8,797	17,715	48,367	788
Streets and roads	412	5,831	2,271	4,568	5,577	1,308	19,967	43,168	78,866	2,066
Buildings, public	772	5,582	969	3,512	2,823	7,541	21,199	50,414	123,713	600
Unclassified, public	237	10,034	101	466	445	1,165	12,448	21,106	19,043	310
Total public	**2,716**	**35,713**	**6,623**	**16,307**	**13,217**	**10,876**	**85,452**	**187,277**	**367,682**	**3,944**
Federal government (included in above classifications)	282	1,709	1,302	2,383	1,451	7,444	14,571	26,716	62,058	.....
Private										
Bridges, private	.....	277	.....	.....	70	.....	347	2,112	1,420	.....
Buildings, industrial	905	6,750	1,425	5,411	1,963	2,685	19,139	61,662	33,124	840
Buildings, commercial	2,490	17,606	635	980	948	820	23,479	41,172	22,572	600
Unclassified, private	260	53,004	223	1,422	1,999	3,872	60,780	70,051	28,248	25
Total private	**3,655**	**77,637**	**2,283**	**7,813**	**4,980**	**7,377**	**103,745**	**174,997**	**85,364**	**1,465**
Total Engineering Construction										
February, 1937 (4 weeks)	**6,371**	**113,350**	**8,906**	**24,120**	**18,197**	**18,253**	**189,197**	.....	.....	**5,409**
January, 1937 (4 weeks)	6,754	58,741	30,563	27,232	34,805	14,982	173,077	.....	.....	4,323
February, 1936 (4 weeks)	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,216
Two months, 1937	13,125	172,091	39,469	51,352	53,002	33,235	.....	362,274	.....	9,732
Two months, 1936	29,989	110,042	73,539	83,400	81,306	74,770	.....	.....	453,046	15,319

ENGINEERING CONSTRUCTION REPORTED BY *ENR* WEEKLY AVERAGES

□—1936 ■—1937



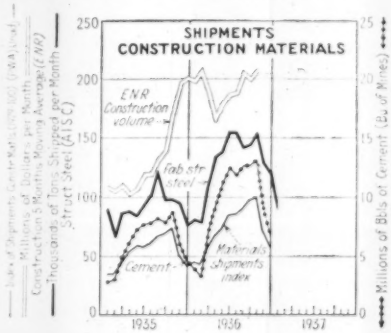
New Capital

New capital for construction purposes during February totals $142,924,000, more than three times the $40,530,000 recorded in January. This includes $62,671,000 in Corporate security bonds, $80,367,000 in state and municipal bonds, $1,971,000 in PWA allotments, and a $7,000 Reconstruction Finance Corporation loan to private industry. The Reconstruction Finance Corporation also sold $2,092,000 in PWA bonds to private investors during the month, a transfer from federal to private investment financing.

The shift from federal to private financing continues, with private investment accounting for 98 per cent of the new construction capital for the month.

Materials

Portland Cement—The Portland cement industry in January 1937 produced 6,633,000 barrels, shipped 4,678,000 barrels, and had 24,396,000 barrels *in stock* at the end of the month, according to reports of the Bureau of Mines. Production and shipments in January showed increases of 81.7 and 19.4 per cent, respectively, compared to January 1936.



The ratio of production to capacity for January is 30.4 per cent, compared to 40.3 per cent in December, and 16.1 per cent in January 1936.

Steel—The operating rate of steel companies having 98 per cent of the steel capacity of the industry who report to the American Iron and Steel Institute averages 81.1 per cent for February, compared with 79.2 per cent a month ago, and 51.7 per cent a year ago.

According to reports of the American Institute of Steel Construction the volume of fabricated structural steel booked in January, 51.4 per cent of normal, is seasonally lower, but exceeds the volume of last January. Total new business in January, 130,651 tons, is approximately 55.9 per cent of normal (normal being the annual average for the years 1928-1931).

January, 1937, shipments of 92,020 tons, or 39.3 per cent of normal, compare with January 1936 shipments of 34.2 per cent of normal.

Lumber—In February, the lumber industry averaged 46 per cent of 1929 production and 58 per cent of 1929 shipments, according to reports of the National Lumber Manufacturers' Association. Production is the heaviest since mid-December and the settlement of the maritime strike boosted shipments to the highest since last October.

Increases in lumber prices are reported in Atlanta, Birmingham, Chicago, Detroit, Kansas City, Los Angeles, New York, St. Louis and San Francisco.

Building Permits

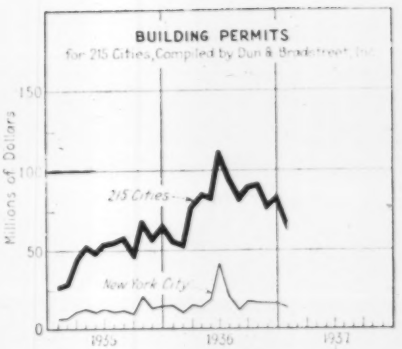
Permits for January for the 215 cities reporting to Dun and Bradstreet, total $68,341,235, a decrease of 18.2 per cent from the $83,557,063 volume in December, and a gain of 24.4 per cent over January 1936. The decline from December is due to seasonal factors, floods and unseasonable weather in many sections of the country.

New York City permits, $12,639,272, show a loss of 22.8 per cent from December, and are 10.4 per cent below January 1936.

Labor

Reports received from 9,522 building contractors employing 97,739 workers in January 1937 show a decline of 11.5 per cent in employment and 13.8 per cent in pay rolls over the month, according to the Department of Labor, Bureau of Labor Statistics. These recessions follow the usual seasonal movement of the private building construction industry in January. Employment in this industry in January 1937 is 33.2 per cent higher than in January 1936 and payrolls are 53.3 per cent greater than in last January. The reports supplied by the cooperating contractors relate to employees engaged in erecting, altering and repairing private buildings and do not include projects financed by Public Works Administration, Reconstruction Finance Corporation funds or regular appropriations of the federal, state and local governments.

Employment on projects of the Works Program is 2,652,000 in January, a decrease of 313,000 compared with the number employed in December. Decreases are occurring on projects operated by federal agencies and on projects operated by the Works Progress Administration. Of the number of workers engaged on the Works Program in January, 2,307,000 employees are working on projects operated by the Works Progress Administration.



Approximately 200,000 workers are employed on construction projects financed by funds provided by the Public Works Administration in January. This is a decrease of 43,000, or 18 per cent, compared with the number employed in December.

The 20-cities wage average compiled monthly by the *Engineering News-Record* is higher in both the skilled and common labor groups. The skilled average rate increase is due to a rise in bricklayer's rate at Atlanta. Increased rates in Atlanta and St. Louis are responsible for bringing the common labor average rate up to a new all time high.

Notice of a wage increase from $1.00 to $1.25 per hour was posted by Local 329 of the United Brotherhood of Carpenters and Joiners of America, in Oklahoma City, Oklahoma, effective immediately.

ENR Cost and Volume Index

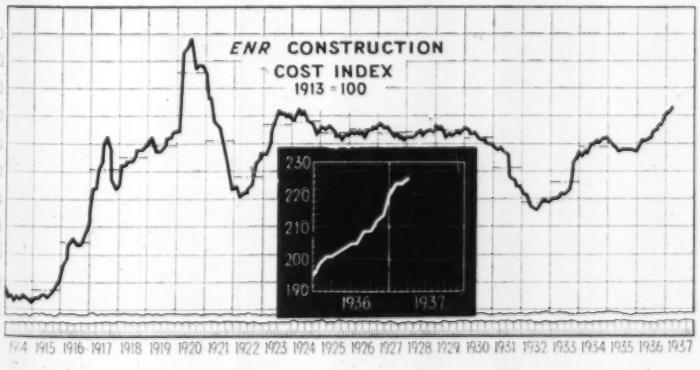
THE February Construction Cost Index reported last month has been corrected to 223.45, due to a correction in the price of lumber.

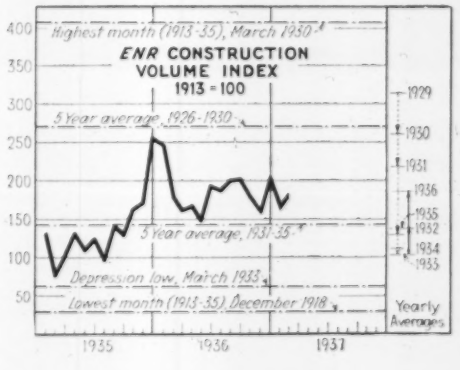
THE *Engineering News-Record* Construction Cost Index rises to 225.25 in March, the highest value since February, 1921. This rise is due to an increase in the common labor wage average.

The *ENR* Volume Index for February is 181.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Mar., 1937	225.25	108.18	Feb., 1937	181	79
Feb., 1937	223.45	107.41	Jan., 1937	167	73
Mar., 1936	201.20	96.71	Feb., 1936	176	77
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50





CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	Ready Mixed 1:2:4, 5.0 sk. or more, delivered
Atlanta	$2.83	$2.58	$2.50	$1.60	$1.60	$1.55	$1.69	$1.92	$1.69	$1.69	$8.50
Baltimore	2.46	2.21	2.01	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	1.80	1.80	7.35
Birmingham	2.40	2.15	1.95	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.75
Boston	2.25*dl*	2.00*vl*	1.80*dl*	1.20	1.20	.85	1.40	1.40	....	....	7.00
Chicago	2.50	2.25	2.10	1.50	1.50	1.50	1.80	1.80	1.00	1.00	....
Cincinnati	2.47	2.22	2.02	1.20	1.20	1.30	1.80	1.80	....	....	6.70
Cleveland	2.40	2.15	....	1.40	1.40	1.10	1.60	1.60	1.75	1.75	7.10*g*
Dallas	2.30	2.05	1.85	1.40	1.40	1.05	1.10	1.15	1.84	1.89	7.00
Denver	3.08	2.85	....	1.20	1.40	.90	....	....	....	....	....
Detroit	2.25	2.00	1.80	1.30	1.30	1.20	1.50	1.60	1.40‡	1.50‡	5.95
Kansas City	2.51	2.26	2.06	1.85	1.85	1.15	1.85	1.80	....	....	7.65
Los Angeles	2.32	2.12	....	1.20	1.20	.90	1.20	1.20	....	....	6.83
Minneapolis	2.80	....	2.35	1.00*p*	1.00*p*	.25*p*	1.00*p*	1.00*p*	....	....	7.00*d*
Montreal	....	2.48*S*	1.70	.80	.85	1.00	1.20‡	1.30‡	....	....	6.50*g*
New Orleans	2.50	2.30	2.05	1.50	1.50	1.25	....	....	....	....	8.35
New York	2.50‡	2.20‡	....	1.10*tk*	1.10*tk*	.70*tk*	1.65*tk*	1.75*tk*	....	....	7.70
Philadelphia	2.55	2.30	2.10	1.45‡	1.55‡	1.15‡	2.40‡	2.55‡	1.00‡	1.00‡	8.00*D*
Pittsburgh	2.45	2.20	1.60	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.00
St. Louis	2.53	2.28	....	1.40‡	1.40‡	1.40‡	.75*p*	.75*p*	.65/.95§	.50/.85§	7.10
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	....	....	7.53
Seattle	2.95	2.70	....	1.33	1.33	1.33	2.25	2.25	....	....	7.50

*10c allowed for each returnable bag. † Per cu. yd. ‡ Delivered. § F.o.b. Granite City, Ill. *k* Barge lots alongside dock. *p* F.o.b. plant. *t* 5 tons or more *z* Within 3-mi. from Public Square. *t* ton. *d* 5% discount for cash. *dl* 10% off for cash 10 days. *D* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *S* Sales tax included.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	1.70	1.65	Ironton, Ohio	$1.50	$1.45	Northampton, Pa.	1.65	1.60
Crestmore, Calif.	1.72	....	Iola, Kans.	1.70	1.65	North Birmingham, Ala.	$1.75	$1.70
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	La Salle, Ill.	1.70	1.65	Richard City, Tenn.	1.85	1.80
Hannibal, Mo.	1.70	1.65	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hudson, N. Y.	1.75	1.70	Mason City, Ia.	1.70	1.65	Universal, Pa.	1.65	1.60
Independence, Kans.	1.70	1.65	Norfolk, Va.	1.76	1.71	Waco, Tex. (Plus 5c Tax in Texas)	1.75	1.70

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

Uniform carload lot cement price established last month lower peninsular Michigan.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE—PARTITION—SCORED (Per M, lots of 2,000 pieces or over, 3x12x12 in.)	(4x12x12 in.)	(8x12x12 in.)	STRUCTURAL CLAY TILE—LOAD BEARING—SCORED (Per M, lots of 2,000 pieces or over, 8x12x12 in.)	(10x12x12 in.)	(12x12x12 in.)	BRICK (Per M, in quantity, Common backing)	(Straight hard)	LIME (Per ton, Hydrated finishing)	(in paper, Common hydrated)	(carload lot, Pulverized or lump)
Atlanta	$71.10	$75.80	$142.10	$170.50	$199.00	$227.40	$12.25	$15.15	$19.50	$14.00	$14.00
Baltimore	91.00	98.00	183.00	219.00	315.00	390.00	13.00	17.00	20.00	14.00	25.00
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	3.00§	1.75§	2.25*c*
Boston	87.75*sl*	93.60*sl*	175.50*sl*	198.90*sl*	210.60*sl*	258.30*s*	16.00	19.00	20.00	15.50	3.50*d*
Chicago	66.00	70.40	132.00	174.30	214.40	245.00	10.20	11.20	18.00	13.40	14.00
Cincinnati	62.00	62.80	117.75	141.30	169.26	209.56	17.50	17.50	15.20	12.30	....
Cleveland	45.00	48.00	90.00	108.00	138.50	158.50	15.00	15.00	16.00k	14.00k	2.65*kp*
Dallas	59.00	62.00	125.00	149.00	155.00	177.00	9.50	24.00	19.00	16.00	.95*z*
Denver	78.50	88.00	141.50	160.65	196.00	225.50	11.50	15.00	30.00k	22.00k	22.50*k*
Detroit	71.85	76.65	143.70	230.00	280.00	325.00	12.50	13.50	18.00	15.00	15.25
Kansas City	64.50	66.50	81.00*	125.50	159.75	186.25	13.00	22.00	18.90	12.40	10.35
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	.....	19.70
Minneapolis	86.30‖	92.05	156.25	192.85	176.20*n*	245.20*n*	13.10	15.10*x*	21.00	16.00	19.00
Montreal	84.00*s*	96.00*s*	180.00*s*	.....	273.00	.....	15.50	20.75	23.50	17.00	11.00
New Orleans	69.00	69.00	129.00	155.05	203.25	251.70	13.00	.....	18.40	11.25	....
New York	78.40	83.60	125.40*	193.30†	238.80†	295.60†	12.00	.....	20.00	15.50	20.00
Philadelphia	80.50	85.90	161.10	193.30	234.40	290.10	15.00	18.00	16.10	10.90	10.40
Pittsburgh	58.40	62.30	116.85	165.00	217.00	250.00	16.50	25.00	17.20	14.50	2.22*p*
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	16.00	17.00	.55‡	.40‡	2.30*p*
San Francisco	84.00	94.50	225.00	.....	.....	.....	15.00	18.00	.55§	.40§	2.65*p*
Seattle	110.00	130.00	210.00	110.00*y*	.....	.....	20.00*d*	20.00	30.00	20.00	28.00*d*

*6x12x12 in. † F.o.b. Perth Amboy, N. J. ‡ Per sack. § Per bbl., 200 lbs. *p* Per bbl., 180 lbs. *q* Per bbl., 280-lb. *k* LCL. *d* less $1 cash 15 days. *c* Lump. *s* Smooth. *x* Selected common. *l* Carload lots delivered to job. *z* Per sack, 100 lbs. *n* - not load bearing *y* - 8 x 8 x 8 only

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS: Granite (per M, lots of 50,000, 4x4x8 in.)	Brick (per M, 3x4x8½ in., carload lots)	Wood (per sq. yd., 3½ in. 16-lb. treat)	PAVING ASPHALT (Per ton, less than 80 penetration, Tank car)	(Drums)	ASPHALT BINDERS—FLUXES (Per gal., 80-300 penetration, Tank car)	(Drums)	CUTBACK ASPHALT (Per ton, Tank car)	(Drums)	ROAD OILS (Per gal., Tank car)	ASPHALT EMULSION (Per gal., Tank car)	(Drums)
Atlanta	$ 75.00	$35.00	$2.25	$18.20 [2]	$23.41 [2]	$0.028 [2]	$0.799 [2]	.0768† [2]	.1089† [2]	$0.668 [2]	$0.0875	$0.0875
Baltimore	110.00	44.00	2.25	17.00	22.00	.075	.10	.09†	.125†	.....	.....	.....
Birmingham	110.00	25.00	....	19.00	24.00	.0878	.1128	.10†	.137†	.....	.06	....
Boston	75.00	46.00	3.60	17.00	22.00	.07*e*	.095*e*	.09†*e*	.125†*e*	.07*e*	.095*e*	.125*e*
Chicago	140.00	42.00	2.50	17.00	22.00	16.00	21.00	.07	.11	.045	.09	.135
Cincinnati	112.00	37.50	....	13.47	17.47	.12	.....	17.00	.....	.051	.078	....
Cleveland	100.00‡	32.50	2.85	17.50	21.20	.075	.094	.085	.055†	.0575	.085	.095
Dallas	.....	32.50	....	19.00	22.75	.075	.10	20.00	28.00	.055	.085	.135
Detroit	.....	37.00	....	16.80*k*	21.00*k*	.....	.....	15.25	20.25	.055	.11	.15
Kansas City	.....	40.50	....	18.50	23.50	17.50‡	22.50‡	.077†	.107†	.057	.11	.15
Los Angeles	.....	50.00	....	10.00	15.16	11.00‡	15.16‡	11.00	.....	.042	.06	.12
Minneapolis	.....	.....	1.90*l*	19.90	26.40	.098	.107	21.85	34.65	.048	.....	.....
Montreal	85.00*	60.00	3.62	14.00	20.00	.10	.13	.0975†	.01125†	.0675	.135	.165
New Orleans	100.00	32.00	....	15.20	18.75	.068	.095	.075†	.10†	.....	.0785	.11
New York	120.00§	65.00	2.75	17.00	22.00	.075	.10	.09†	.125†	.....	.075	.11
Philadelphia	120.00	52.00	....	15.00	20.00	.06	.085	.065†	.095†	.055	.07	.10
Pittsburgh	115.00	40.00	....	19.00	24.00	.077	.1125	.086†	.121†	.0675	.....	.....
St. Louis	115/120	36.00	....	19.00	24.00	.0775	.1075	.0825†	.1125†	.045	.09	.12
San Francisco	.....	50.00	....	12.00	18.00	12.00‡	18.00‡	12.50‡	23.00‡	.04	.0575	.117
Seattle	.....	40.00	....	25.50	25.50	17.00‡	23.00‡	15.00	.....	.03	.19	.220

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N.J., per ton, Permudez, $25.00; Trinidad, $21.00. *Sales tax included. †Per gallon. ‡4½x6x5½ in. ‖Per ton. § 4x5x9 in. Av. *k* Mexican. [2] Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *l* 2½ in. 6 to 8-lb. treatment. *e* F.o.b. Everett

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¾-in. billet	RIVETS ½-in. structural	WIRE NAILS Base	SHEET PILING Base	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES: Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$2.20	$2.30	$3.35	$2.55		$39.00	$38.00	$37.00	$2.70	$2.90	$2.10	$4.00
Chicago	2.10	2.30	3.35	2.15	$2.50	39.00	38.00	37.00	2.70	2.90	2.10	4.00
Pittsburgh	2.05	2.20	3.20	2.40	2.40	39.00	38.00	37.00	2.70	2.90	2.10	4.00

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

F.O.B. WAREHOUSE	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¾ in., base price: New billet	Rail steel	EXPANDED METAL LATH Per 100 sq. yd. carload lots: Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots: 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$3.49	$2.54	$2.37	$21.00	$23.00	$1.63	$1.23	$0.1548	$2.70
Baltimore	3.10	2.75	2.60	25.00	28.00	1.50	1.14	.1422	2.45
Boston	3.79	2.66	2.44	23.50†	25.50†	1.56	1.18	.1476	2.82
Chicago	2.10	2.30	2.10	20.00	22.00	1.49	1.14	.1413	2.50
Cincinnati	3.65	3.40	3.40	25.01	29.50	1.48	1.13	.1404	
Cleveland	3.31	2.75	2.60	20.00	22.00	1.47	1.12	.1386	
Dallas	2.45	2.65	2.60			1.74	1.30	.1647	2.85
Denver	4.18	3.80	3.65	22.00	25.00	1.75	1.30	.1665	
Detroit	3.65	2.84	2.69	20.00†	22.00†	1.50	1.14	.1422	2.65
Kansas City	3.94	2.84	2.69	19.00	21.00	1.60	1.21	.1521	2.92
Los Angeles	2.35	2.625		23.00	27.50	1.77	1.32	.1683	2.65
Minneapolis	3.70	2.99	2.84	24.00	28.00	1.59	1.20	.1512	2.80§
Montreal	2.90	2.40	2.40	32.50	35.50	2.46	1.82	.253	2.80
New Orleans				20.75	23.75	1.64	1.23	.1557	
New York	3.62	2.68	2.53	18.50	20.50	1.53	1.16	.1449	2.73
Philadelphia	3.10	2.76	2.21	18.50	20.50	1.51	1.15	.1431	2.40
Pittsburgh	2.07½‡	2.20‡	2.05‡	20.00‡	22.00‡	1.43	1.10	.1350	2.425
St. Louis	3.69	2.59	2.44	24.00	26.00	1.50	1.13	.1422	2.35
San Francisco	3.65	2.725	2.575	24.50	26.50	1.77	1.31	.1683	3.15
Seattle	3.55	3.00		25.00	30.00	1.77	1.31	.1683	2.60

‡Base Mill Price plus switching charge. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis. ††f.o.b. delivered.

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb in 500-lb. lots Dry	WHITE LEAD Per 100 lb. in 500-lb. lots in oil	READY-MIXED PAINT Per gal., drums: Graphite*	Aluminum†	Ferric Oxide‡	ROOFING SUPPLIES Carload lots, f. o. b. factory: Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch, 350 lb. bbl., per ton
Atlanta	$11.25	$11.875	$1.60	$2.50	$1.40	$1.94	$1.70	$1.70	$.36	$25.60
Baltimore	11.00	11.50	1.45	2.25	1.70	2.03	3.00	3.00	.35	25.00
Birmingham	11.25	11.875	2.35	2.35	1.85	2.01	1.77	1.77	.36	22.00
Boston	11.00	11.50	1.80	2.50	.0475x	1.75	2.25k	2.25k	.45	20.00
Chicago	11.00	11.50	1.80			2.48	2.37	2.37	.43	33.00
Cincinnati	11.00	11.50	1.45	2.50	1.40	2.40	2.39k	2.39k	.36	21.00
Cleveland	11.00	11.50	1.70	2.45	1.40	1.55	1.75k	1.75k	.23	19.00
Dallas	11.25	12.25	1.80	2.10		2.75k	2.50k	2.50k	.60	60.00
Denver	11.50	12.00	2.55			2.25x	3.55	3.55	.35	30.00
Detroit	11.00	11.50	1.65	2.40	1.40	2.40	2.65	2.50	.35	30.00
Kansas City	11.00	11.625	1.83	2.79	1.21	1.78	3.15	3.15	.25	24.50
Los Angeles	11.25	11.75	1.60	2.25	2.30	2.00	1.50		.45	
Minneapolis	11.00	11.625				1.85v	1.78kv	1.78kv	.29	23.80
Montreal		8.20	2.00	4.75	2.40	2.50	1.60	1.83	.50	1.52§
New York	11.00	11.50	1.85	2.50	1.55	1.85	1.62k	1.78k	.232	22.00
Philadelphia	11.00	11.50	2.515	2.94	1.515	1.75	1.86k	1.48k	.29	25.00
Pittsburgh	11.00	11.50	1.05	1.95	.80	1.90	1.82k	1.82	.34	20.00
St. Louis	11.00	11.50	1.60/1.85	2.40/2.45	1.40/1.70	1.83k	2.57	2.57	.25	25.00
San Francisco	11.25	11.50	1.80	2.75	1.10–2.00	1.54	1.90	1.90	.325	22.00
Seattle	11.25	11.75	1.80	2.85	2.20	1.97	2.42	2.60	.60	28.00

*U. S. War Dept. Spec. 3-49A. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. §Per 100 lb. kPer roll, 65 lb. xPer lb. vMinneapolis & vicinity.
Note: Red lead in oil 50c higher than white lead in oil. ‡Basis of quoting changed this month from list to 500-lb. lots. sSales Tax included.

MISCELLANEOUS ITEMS

	WINDOW GLASS Discounts from latest jobbers List, Sept. 15, 1928 Single or Double Thickness: A quality	B quality	EXPLOSIVES Per lb. dynamite delivered 50-lb. cases Gelatin: 40%	60%
Atlanta	75%	75%	$0.15	$0.165
Baltimore	84%	86%	.45	.16
Birmingham	88%	90%	.095	.11
Boston	87%	88%	.13	.145
Chicago	85%	86%	.105c	.12c
Cincinnati	89–10%	91–10%	.27	.29
Cleveland	85%	85%	.215	.225
Dallas	80%	80%	.16	.170
Denver	84%	85%	.15	.16
Detroit	87–10%	89–10%	.21	.24
Kansas City	83–10%	82–10%	.15	.165
Los Angeles	90%*	90–40%	.1725†	.1925†
Minneapolis	83%	84%	.16	.175
Montreal	60–30%	70–5%	.18	.1925
New Orleans	88%	90%	.215	.23
New York	85%	87%	.215x	.23x
Philadelphia	85%	86%	.145	.16
Pittsburgh	85%	86%	.1325	.1475
St. Louis	89%	89%	.145	.165
San Francisco	78%	83%	.1475	.1625
Seattle	83%	86%	.1425	.1575

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal. ‡Double thickness A & B.
xManhattan only – other Boroughs $6 per trip. c carload lots.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York.	
Bleaching powder, in drums, F.o.b. works, per 100-lb.	$2.00–2.10
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	22.00–35.00
Chlorine cylinders, per lb. delivered	.055
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.35
Soda ash, 58%, in paper bags, per 100 lb. dense	1.23
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	27.00
Sulphate of copper, in bbl., per 100-lb.	4.85

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail	Long Leaf Barge	Long Leaf Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.16	$0.195	$0.16	$0.19
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.20	.24	.18	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21	.255	.205	.24½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.23	.265	.23½	.27½
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.25	.275	.27½	.33½
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.37	.415		
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.40	.482		

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston: Oak, untreated	$1.10	$1.50
Pine, untreated	1.10	1.50
Pine, creosoted	1.60	2.25
New York: Long-leaf sap pine, untreated	1.05	1.25
Mixed oak, untreated	1.20*	1.40
White oak, untreated	.85	1.35
White oak, creosoted	1.50	1.70
Birmingham: Southern pine, untreated *6 x 8 x 8' 6"	.55*	.70
Southern pine, creosoted	1.10*	1.30
White oak, untreated	1.25	1.55
Oak, empty cell, creosoted	1.67	2.05
Chicago: Oak, zinc treated	1.55	1.90
Southern pine, creosoted	1.50	1.95
Fir, untreated	.50	.72
Los Angeles: Fir, creosoted	1.67	2.40
Red oak, untreated	1.00	
Philadelphia: Red oak, creosoted		2.10
White oak, untreated	1.20	1.50
Red oak, untreated	1.15	1.40
St. Louis: Red oak, creosoted	1.50	2.15
Sap pine or cypress, untreated	1.00	1.20
San Francisco: Douglas fir, green, untreated	1.05	.63
Douglas fir, empty cell, creosoted	1.14	2.35
Montreal: Birch or maple, untreated	.65	.75
Birch or maple, creosoted	1.05	1.35

CURRENT PRICES OF CONSTRUCTION MATERIALS

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE			
	Per net ton, f.o.b. 6 in. to 24 in.*	Per foot, delivered, ASTM C 13-35				Per 1,000 ft., carload lots., f.o.b.		Per ft., delivered; ASTM C 14-35		Full standard weight. ‡ 1 to 3 in., Butt Weld		3½ to 6 in., Lap Weld	
		8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	6 in.	8 in.	12 in.	24 in.	Black c/c	Galv. c/c	Black c/c	Galv. c/c
Atlanta	$45.00	0.26dl	$0.468dl	$1.629	$4.501	$85.00	$128.00	$0.45	$1.625	49.5	40.5	47	32.5
Baltimore	48.50	.28	.54	2.38	7.18	110.00	170.00	.40	1.60	....	....	....	....
Birmingham	41.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	69.5	61.5	67	58.5
Boston	48.50	.224	.432	1.98	5.845	99.00	153.00	.43	2.40	....	....	....	....
Chicago	49.50	.245	.4725	2.025	4.60	60.00	120.00	.36	1.42	58.75	48.75	55.625	46.5
Cincinnati	48.00	.189	.3645	1.62	5.535	69.00	108.00	.40	1.40	58.75	48.75	55.625	46.19
Cleveland	49.50	.182	.351	1.53	4.8175	69.00	108.00	.32	1.64	61	51	57.9	42.25
Dallas	53.00	.40	....	....	....	160.00	260.00	.46	1.57	69.5	61.5	67	58.5
Denver	61.00	.27‡	.47‡	1.98‡	....	105.00	180.00	....	....	50	40	47	36
Detroit	49.50	.203	.3915	1.71	5.2375	82.00	136.00	.35	1.20	59.3	49.3	56.1	45.5
Kansas City	51.00	.30	.54	2.16	5.00	120.00	140.00	.40	1.50	55	45	52.0	41.5
Los Angeles	49.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	62.1	54.1	59.6	51.1
Minneapolis	51.50	.24‡	.432‡	1.728‡	4.60‡	....	....	.65	1.75	....	....	....	....
Montreal	55.00	.33‡	.59‡	2.04‡	....	82.00	134.00	.51	2.04	....	....	....	....
New Orleans	47.00	.23	.41	1.60	....	67.00	....	.47	1.67	....	....	....	....
New York	48.00	.24	.49	2.20	6.10	....	....	.55	2.00	57.50z	47.50z	54.375z	43.75z
Philadelphia	45.00	.196	.378	1.755	5.33	100.00	150.00	.54	1.80	52.37z	41.35z	53.39z	42.52z
Pittsburgh	51.00	.168‡	.324‡	1.35‡	4.92‡	52.00	81.00	.75c	1.75	69.5	61.5	67	58.5
St. Louis	48.80	.28	.504	2.016	3.96	85.00	170.00	1.00	2.25	57.125	47.125	54	43.375
San Francisco	49.00	.29L	.522L	2.088L	5.67L	103.50	172.50	.45	2.20	59	49	52	41
Seattle	50.50	.420	.63†	3.06†	7.55†	85.00	200.00†	.50†	1.60	65.80	57.25	66.75	56.30

* b. & s. class B and heavier, C/L lots, 200 tons and over. Burlington, N. J. (base) $45.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional. 30 in. and larger usually $2 per ton less.

‡ f.o.b. † Less 30% in C/L Lots. c Concrete Culvert pipe reinforced. d Double strength. l List to dealers. L list. t Sales & municipal taxes extra.

Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c.; ⅜ in. 11½ c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½ c.; 4 in., $1.09; 6 in., $1.92.

^ 2½ to 3 in. z Resale price to consumer, car load lots shipped from mill.

LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

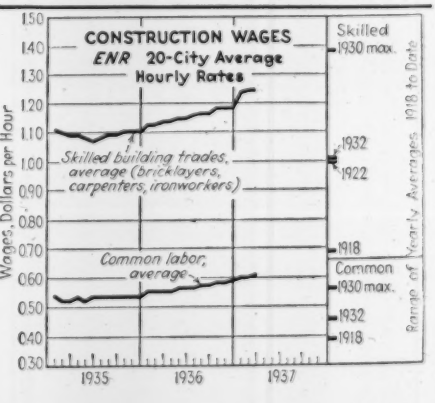
	SHORT LEAF YELLOW PINE AND DOUGLAS FIR—All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face). *All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*								LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note)	
	1x6,§	1x8,§	2x4,§	2x6,§	2x8,§	2x10,§	3x12,#	6x12,#	12x12,#	2x12,#	12x12,#	⅜"	¼"
Atlanta	**$22.00**	**$22.00**	**$23.00**	**$23.00**	**$24.00**	**$25.00**	**$30.00**	.....	.....	$50.00	$50.00	$16.80	$20.50
Baltimore	**25.50**	**26.00**	**28.50**	**27.50**	**29.00**	**30.50**	**41.00**			58.00	59.00	16.45W	20.05W
	32.00	*32.00*	*31.00*	*30.50*	*30.50*	*31.00*	*33.50*	*$35.50*	*$34.00*	.....	.....		
Birmingham	**26.00**	**26.00**	**27.00**	**26.00**	**26.50**	**28.00**	**38.00**	**37.00**	**37.00**			15.55	18.95
	28.00	28.00	32.00	30.00	33.00	35.00	54.00	.....	.....	55.00	53.00	.....	.....
Boston	32.00[2]	32.00[2]	35.00[3]	35.00[3]	51.00[1]	60.00[1]	75.00[1]			75.00	75.00	16.45W	20.05W
	32.00	*32.00*	*35.00*	*35.00*	*40.00*	*40.00*	*45.00*	*48.00*	*48.00*	.....	.....		
Chicago	**35.00**	**35.00**	**36.00**	**36.00**	**36.00**	**36.00**	**50.00**	.....	.....	60.00	60.00	12.45	15.15
Cincinnati	**25.50**	**25.50**	**25.50**	**24.50**	**25.50**	**28.50**	**39.50**			41.00	44.00	15.55	18.95
	.....	.....	.....	.....	.....	.....	*43.75*	*43.75*	*43.75*	.....	.....		
Cleveland	**30.00**	**32.00**	**38.00**	**32.00**	**36.00**	**38.00**	**49.00**	*44.00*	*43.75*	52.00	64.00[8]	15.55	18.95
Dallas d	**33.50**	**35.00**	**38.50**	**32.50**	**35.00**	**36.50**	**46.50**	**51.50**	**66.00**	42.50	85.00	13.15	16.05
Denver *	*42.00*	**42.00**[4]	*43.00*	*43.00*	*43.00*	*47.00*	*52.00*	*56.00*	*61.50*	.....	.....	9.35	11.35
Detroit	**35.00**	**35.00**	**35.00**	**35.00**	**35.00**	**37.50**	**44.00**			32.00	44.00	15.55	18.95
	.....	.....	.....	.....	.....	.....	*47.50*	*47.50*	*50.00*	40.00	50.00		
Kansas City	**32.00**	**32.00**	**32.50**	**31.50**	**31.50**	**32.50**	**40.00**			56.00	62.00	11.45	13.95
	29.50	*29.50*	*34.00*	*33.50*	*33.50*	*36.00*	*35.00*	*39.00*	*39.00*	.....	.....	.....	.....
Los Angeles †	*40.00*	*39.00*	*40.00*	*39.00*	*41.00*	*41.00*	*48.00*	*54.00*	*49.00*	.....	.....	8.90WX	10.80WX
Minneapolis *‡	45.00[6]	51.50[6]	50.00[6]	41.00[6]	41.00[6]	42.00[6]	.....	.....	.....	58.00[6]	.....	11.45	13.95
*	*42.00*	*42.00*	*43.00*	*43.00*	*43.00*	*43.00*	*55.00*	*59.50*	*59.50*	54.00	.....	.....	.....
Montreal [7]	45.00	45.00	49.00	47.00	48.00	58.00	.....	.....	.....	.....	.....	.....	.....
	39.50	*39.50*	*40.00*	*40.00*	*40.00*	*41.50*	*42.00*	*42.00*	*42.00*	82.00	76.00	.....	.....
New Orleans	**23.50**	**25.50**	**28.00**	**25.00**	**27.00**	**25.50**	**38.00**	.....	.....	44.00	54.00	13.15	16.05
	28.50	*30.00*	*33.00*	*29.00*	*32.00*	*33.50*	*37.00*	.....	.....	.....	.....	.....	.....
New York *	**37.50**	**39.00**	**37.50**	**39.00**	**39.00**	**42.00**	**47.50**			80.00	77.50	16.45W	20.05W
*	.....	.....	*47.50*	*47.50*	*47.50*	*47.50*	*52.00*	*57.50*	*57.50*	.....	.....	.....	.....
Philadelphia	**28.50**	**28.50**	**28.50**	**29.00**	**29.50**	**30.50**	**38.50**			60.00	60.00	16.45W	20.05W
	45.00	*45.00*	*45.00*	*45.00*	*45.00*	*45.00*	*45.00*	*42.00*	*42.00*	.....	.....	.....	.....
Pittsburgh	**38.10**	**39.90**	**47.05**	**42.00**	**45.65**	**46.90**	**59.70**	.....	.....	57.50	57.50	16.20	19.20
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	.....	.....	.....	.....
St. Louis *§	**35.50**	**36.50**	**35.00**	**34.00**	**35.00**	**36.00**	**49.50**	*56.00*	*56.00*	73.00	72.00	13.15	16.05
San Francisco. *	*24.50*	*22.00*	*25.00*	*22.50*	*24.50*	*22.50*	*27.00*	*22.00*	*22.00*	.....	.....	6.95W	8.50W
Seattle	*16.50*	*16.50*	*16.50*	*15.50*	*15.50*	*15.50*	*21.00*	*20.00*	*20.00*	.....	.....	0.00	0.00

§ S4S. # Rough. * All prices delivered. † Yard prices. ‡ Contractors in Minneapolis & St. Paul get 15% disc. from list. § 5M ft. or 'ess * At ship's tackle. d10% Disc. taken off. [1] Long leaf. [2] Roofers N.C. Pine. [3] Spruce. [4] Native. [5] Northern Pine. [6] Western Pine. [7] Pine. [8] Norway Pine. Dec. prices, Jan. prices not available due to strike. Bold face type, Southern Pine. Italics, Douglas Fir.

Note: Special concrete form grade Fir Plywood, 4'x8' panels, 5-ply, sanded 2 sides, water resistant glue, car load lots, delivered per 1000 sq. ft. surface. Base price—Seattle: ⅜", $70.125; ½", $80.025. For other centers add rail freight increment from table for proper size. Add: for form oil treatment $2.50 per M. sq. ft.; for mineral paint sealed edges, $1.00 per M; for resin dipped treatment $10.00 per M.

W Lower rate by water shipment. X 50,000 lb. minimum.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor—Building	Common Labor—Heavy Const.
Atlanta	$1.25	$0.40/1.00	$1.25	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.25	1.10	1.375	1.25	1.25	.45	.45
Birmingham	1.00	1.00	1.25	1.125	1.00	.30/.40†	.30/.40†
Boston	1.50	.90/1.375	1.375	1.00/1.375	1.625	.60/.80	.60/.85
Cincinnati	.80/1.375	.65 1.20	1.25	1.00/1.25	.80/1.375	.45	.45
Chicago	1.50	1.50	1.50	1.50	1.50	.95	.95
Cleveland	1.375	1.25	1.25	1.25	1.50	.825	.825
Dallas	1.25	1.00	1.00	1.00	1.25	.40	.40
Denver	1.25	1.25	1.25	.....	.....	.625	.625
Detroit	1.25	1.00	1.25	1.25	1.25	.60/.75	.60/.75
Kansas City	1.325	1.25	1.25	1.25	1.45	.80	.45/.50
Los Angeles	1.10	1.10	1.125	1.125	1.25	.60	.60
Minneapolis	1.25	1.10	1.25	1.25	1.35	.75	.75
New Orleans	1.00	.75	1.00	1.00	1.25	.30/.40	.30/.40
New York	1.50	1.40	1.65	1.50/1.65	1.50	.825	.50/.80
Philadelphia	1.50	1.00	1.375	1.50	1.375	.40/.50	.40/.50
Pittsburgh	1.50	1.25	1.375	1.00	1.50	.70	.50
St. Louis	1.50	1.25	1.75	1.57/1.75	1.50	.875	.35/.875
San Francisco	1.50	1.125	1.375	1.125	1.50	.75	.60
Seattle	1.50	1.125	1.25	1.25	1.50	.80	.80
Montreal	.70	.60	.65	.55	.70	.40	.35

Skilled Avg.: (Bricklayers, Carpenters, Ironworkers) $1.246; Common Avg. $0.612. † PWA.